CORPS OF ENGINEERS, U. S. ARMY

CHANNEL IMPROVEMENTS, FARM CREEK, ILLINOIS

HYDRAULIC MODEL INVESTIGATION

TECHNICAL MEMORANDUM NO. 2-355

CONDUCTED FOR

CHICAGO DISTRICT, CORPS OF ENGINEERS

BY

WATERWAYS EXPERIMENT STATION

VICKSBURG, MISSISSIPPI

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PREFACE

The study described herein was initiated by the District Engineer, Chicago District, CE, authorized by the Chief of Engineers, U. S. Army, and conducted by the Waterways Experiment Station.

An engineer of the Waterways Experiment Station inspected the prototype project and discussed the problem with representatives of the Chicago District before the model study was undertaken. Messrs. E. W. Nelson, R. Berk, and H. H. Schipper of the Great Lakes Division and Messrs. R. F. Leeper, R. T. Snider, and W. J. Santina of the Chicago District visited the Waterways Experiment Station at intervals during the course of the model study to program tests and to discuss test results. Reports describing progress of the study were submitted monthly to the District Engineer.

The model study was conducted by the Hydraulics Division of the Waterways Experiment Station during the period March 1949 to September 1950. Engineers actively connected with the study were Messrs. G. B. Fenwick, J. J. Franco, R. G. Cox, and C. D. McKellar.

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SUMMARY

Proposed channel improvements designed to prevent damage from flash floods in the lower reaches of Farm Creek, a tributary of the Illinois River, near the city of Peoria, Illinois, were tested in a fixed-bed model, built to an undistorted linear scale ratio of 1:60.

The results of the model investigation indicated that: (a) the proposed channel improvements will permit safe passage of the design flood; (b) minor changes in the improvement plans will greatly improve flow conditions; and (c) the capacity of a diversion channel can be increased sufficiently by enlargement of its cross section and redesign of its interceptive works to preclude the necessity of improvements in the main channel downstream.

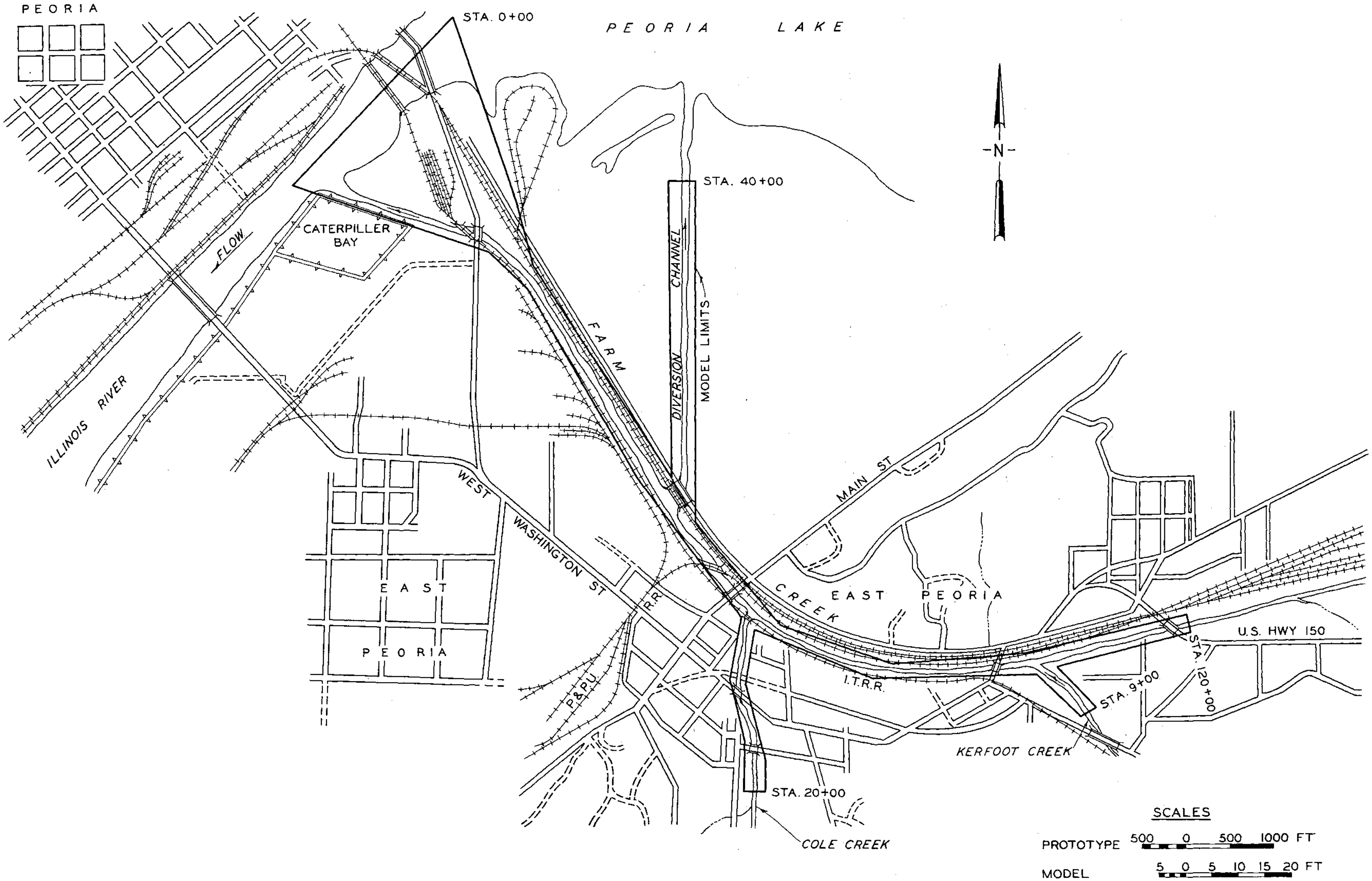

Fig. 1. Farm Creek Model limits; note highly industrialized location

CHANNEL IMPROVEMENTS, FARM CREEK, ILLINOIS

Model Investigations

PART I: INTRODUCTION

The Prototype

1. Farm Creek, a small stream having a total drainage area of 61.1 square miles, rises in eastern Tazewell County in central Illinois, and flows in a generally westerly direction for a distance of some 19 miles to its junction with the Illinois River near the city of Peoria (see figure 2). The upper reaches of Farm Creek and its tributaries are characterized by narrow floodplains and rolling hills predominantly undeveloped or devoted to agriculture. The lower reaches of the creek, where its wide floodplain merges into that of the Illinois River, are bordered by the highly industrialized city of East Peoria (figure 1). On either side of the floodplain are steep abutting hills. The topographical characteristics of the Farm Creek basin are conducive to flash floods of short duration and high rates of discharge. Damage in the upper basin from such floods is minor. However, some 1200 acres in the lower basin, consisting of residential and business districts as well as intensively industrialized sections, are subject to

Fig. 2. Vicinity map

potentially disastrous floods.

2. The creek has five principal tributaries, three of which (Dempsey, Kerfoot, and Cole Creeks) enter Farm Creek within the corporate limits of East Peoria. A man-made diversion channel flows in a northerly direction from the left bank of Farm Creek, in the heart of the industrialized area, to the Illinois River.

3. The flood hazard within the corporate limits of the city of East Peoria and vicinity results from the extremely limited channel capacity of lower Farm Creek and is greatly increased by confining railroad tracks and restricting bridge openings which entrap portions of the large debris load carried by the creeks during flood flows. This debris load further reduces channel capacities and increases flood heights.

The Definite Project Plan

4. Investigation of the flood problems in the Farm Creek basin was undertaken by the Corps of Engineers in 1939 and construction of the Farm Creek Flood Control Project was authorized by the Flood Control Act approved 22 December 1944, Public Law 534, 78th Congress. The protection plan provides for two upstream detention reservoirs controlling 52 per cent of the drainage area, levee construction and channel improvements in the vicinity of East Peoria, and modifications to the Farm Creek-Peoria Lake diversion channel.

The design flood

5. Examination of existing hydrological records on the problem basin and computations made thereon resulted in the selection of 22,000 cfs as the design flow for channel improvements in the lower reaches of

Farm Creek. The design flow is the maximum expected flood flow from the upper reach of Farm Creek, including minor outflows from the detention reservoirs, and 2,600-cfs and 3,900-cfs flows from Cole and Kerfoot Creeks, respectively. The maximum design flow derived for upper Farm Creek is 15,500 cfs, for Cole Creek 3,600 cfs, and for Kerfoot Creek 5,300 cfs. However, the timings of peak flows from Farm, Cole, and Kerfoot Creeks are such that the simultaneous combined discharge from the three streams is not expected to exceed 22,000 cfs.

The initially proposed
improvement plan

6. That part of the definite project plan that provides for improving flow conditions in Farm Creek and its tributaries within the city limits of East Peoria by enlarging and improving the existing channels includes the following specific items (see figure 3, following page).

7. Farm Creek. The bankfull capacity of Farm Creek channel is to be increased from 16,000 cfs to 22,000 cfs by the following measures:

a. The channel to have a slope of 0.002 within the improved area from sta 0+00 to sta 211+20. The existing stable general slope is 0.0025.

b. The channel to be deepened and widened between sta 0+00 and sta 121+44, portions thereof paved where velocities will exceed 8.5 ft per sec, and control structures provided at sta 17+50, 100+72 and 116+00.

c. Existing levees to be improved and new levees to be constructed to provide a 2-ft freeboard throughout the improved area.

d. Alignment of channel to be altered between sta 169+90 and sta 211+20 to provide better bank protection in the vicinity of the Toledo, Peoria and Western Railroad bridge located at sta 190+08; channel alignment to include pilot channels having bottom widths of 20 ft from sta 178+96 to sta 190+08, and 100 ft from sta 190+08 to sta 211+20.

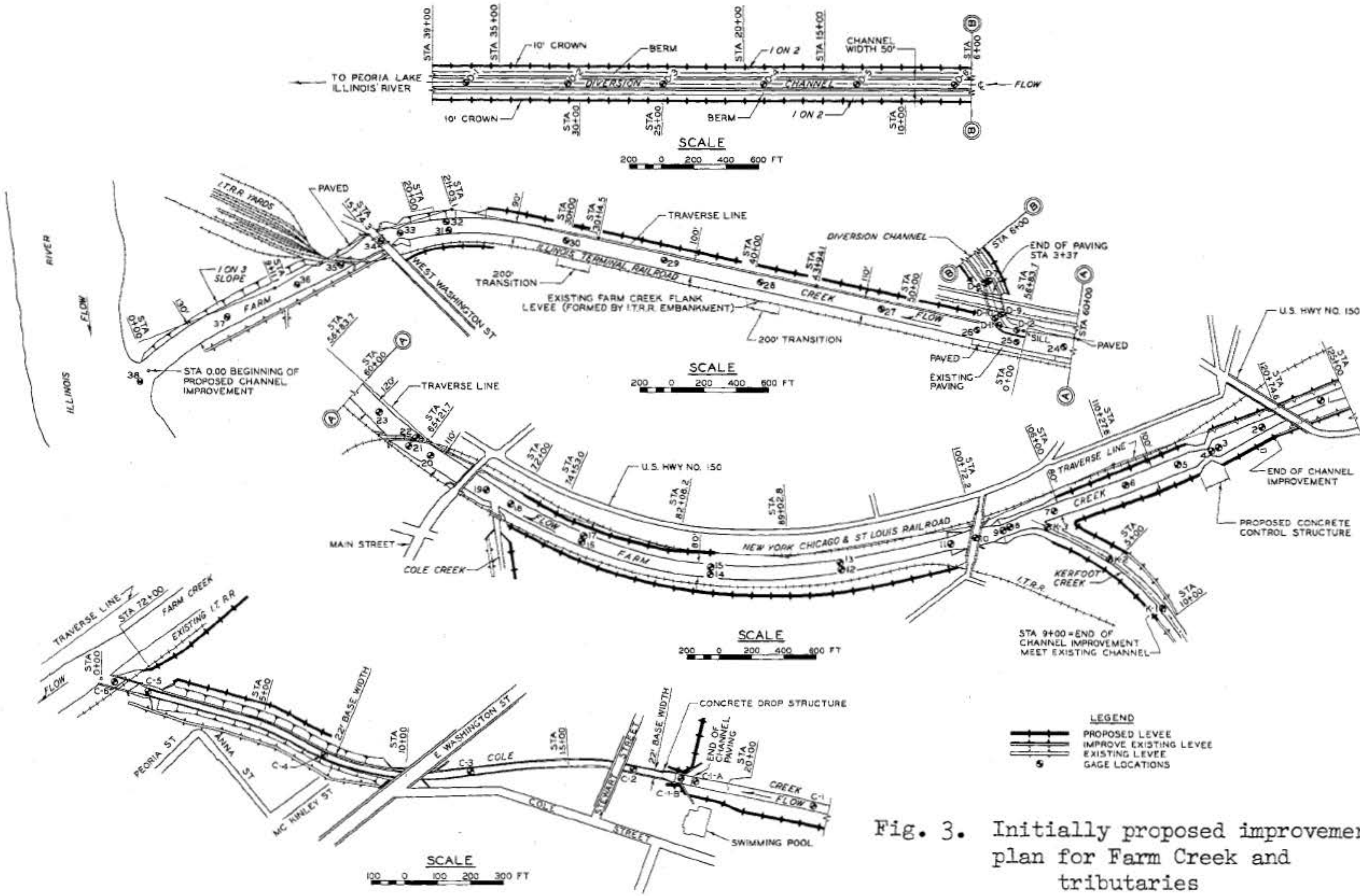

Fig. 3. Initially proposed improvement plan for Farm Creek and tributaries

In general, the definite project plan provides for paving the channel where erosion might result from velocities exceeding 8.5 ft per sec, and for control structures designed to reduce velocities and thereby avoid extensive channel paving. Computed design velocities between sta 0+00 and sta 11+00 exceed 8.5 ft per sec, but no erosion protection is to be provided in this reach because levee failure would not cause serious damage between sta 0+00 and sta 8+00, and because the left bank between sta 9+00 and sta 11+00 is adequately protected by riprap where levee failure would result in extensive damage.

8. Diversion channel. The bankfull capacity of the Farm Creek-Peoria Lake diversion channel is to be increased from 6,000 to 8,000 cfs by the following improvements (figure 3):

a. Installation of an interceptor at sta 0+00.

b. Enlargement of the channel section and construction of levees to provide a 2-ft freeboard between sta 3+37 and Peoria Lake.

9. Cole Creek. The bankfull capacity of Cole Creek to be increased from 2,000 cfs to 3,600 cfs by the following improvements (figure 3):

a. Realignment and paving of the channel from sta 0+00 to sta 1+90 to improve hydraulic conditions at its confluence with Farm Creek.

b. Realignment, enlargement, and paving of the channel from sta 1+90 to sta 18+00 to provide a 22-ft-wide rectangular section.

c. Installation of a drop structure at sta 18+35.

d. Replacement of two existing two-span highway bridges with clear-span bridges and relocation of the Illinois Terminal Railroad bridge.

e. Construction of required levees to provide a 2-ft freeboard between sta 0+00 and 18+50.

10. Kerfoot Creek. The bankfull capacity of the lower reach of Kerfoot Creek is to be increased from 4,800 cfs to 5,300 cfs by the following improvements:

a. Realignment and paving of the channel from sta 0+00 to sta 1+20 to improve hydraulic conditions at its confluence with Farm Creek.

b. Realignment and enlargement of the channel from sta 1+20 to sta 9+00 to improve channel conditions.

c. Construction of required levees to provide a 2-ft freeboard between sta 0+00 and 9+00.

Need for and Purpose of Model Study

11. The improvements proposed for Farm Creek and its diversion channel and tributaries include numerous structures involving hydraulic problems that could not be conclusively solved by computations. These problems consisted mainly of determining losses resulting from control structures, bridge piers, variable channel sections, stream confluences, and an interceptor wall. The Farm Creek model was designed and built to test the hydraulic performance of these proposed structures and to correct any unsafe or undesirable conditions resulting from their installation. In addition, the computed capacities of the various channels were to be checked and the combinations of discharges, if any, that would produce undesirable effects at the locations of hydraulic jumps, thereby affecting the structural design assumptions for uplift or bank protection, were to be determined.

PART II: THE MODEL AND THE TESTING PROGRAM

Description of Model

12. The Farm Creek model (figure 4) was a scale reproduction of a small section of the Illinois River, of Farm Creek from its mouth to

Fig. 4. The Farm Creek model

sta 120+00, of the diversion channel from its origin at Farm Creek to sta 40+00, of Kerfoot Creek from its confluence with Farm Creek to sta 9+00, and of Cole Creek from its confluence with Farm Creek to sta 20+00.

13. The model was of the fixed-bed type with all channel and overbank areas molded in cement mortar to female templets. The required model roughness was obtained by varying the texture of the mortar finish.

Channel areas to be paved in the prototype were reproduced in the model by a trowel-finished surface, unpaved areas by a thin stucco veneer, and riprapped areas by brush-finished concrete (figure 5). All model bridge

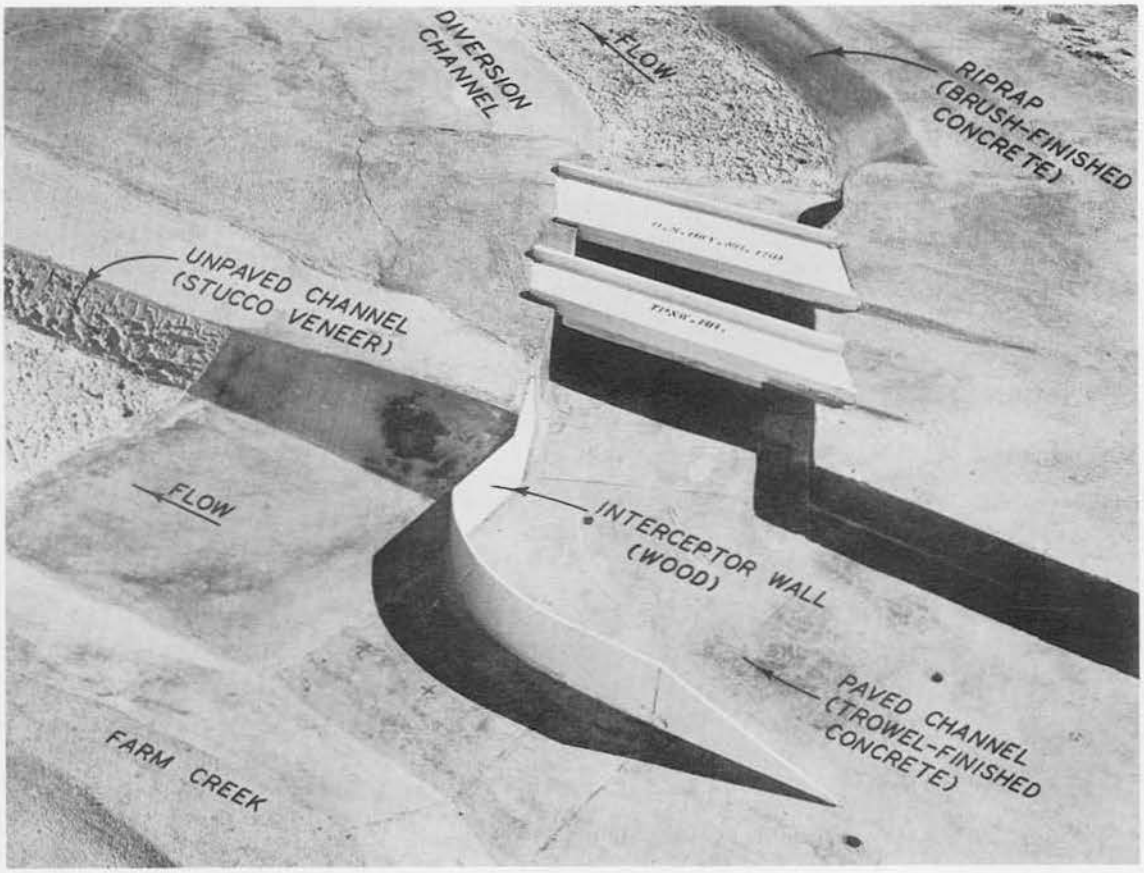

Fig. 5. Types of roughness used in the model

piers, end sills, and interceptors were fabricated from wood.

14. The model was built to an undistorted scale of 1:60, model to prototype, to effect accurate reproduction of hydraulic conditions at drop and control structures and of the water surfaces at obstructions and changing sections. Other scale ratios, computed directly from the linear scale ratio, were: area, 1:3600; volume, 1:216,000; discharge, 1:27,900; velocity and time, 1:7.74.

Appurtenances and Their Applications

15. Water used in operation of the model was supplied by a circulating system with discharges measured by a venturi meter and Van Leer and V-notch weirs. Flows were introduced into upper reaches of Farm Creek through the venturi meter and into the upper reaches of Kerfoot and Cole Creeks by means of Van Leer weirs. Outflows from the model at the confluence of Farm Creek and the Illinois River and at the end of the diversion channel were measured by means of V-notch weirs. Adjustable tailgates controlled water-surface elevations in the lower reaches of the model.

16. Water-surface elevations throughout the model were measured by means of 61 piezometer-type gages located in the four channels reproduced in the model (table 1 and figure 3). A portable point gage was used to obtain water-surface elevations at critical locations not covered by the permanent gage installations.

17. Velocities were measured with a Bentzel tube.

Testing Program

18. The study was divided into three distinct testing phases: (a) adjustment of the model to insure accurate reproduction to model scale of the Manning's "n" values used in computations on which the design of proposed channel improvements was based; (b) testing of the design plan; and (c) testing of modifications to the design plan.

Model Adjustment

19. Inclusion of the proposed Farm Creek channel improvements in

the initial model construction precluded adjustment of the model to known prototype data. Therefore, it was necessary to insure that the model roughness values were comparable to those existing in the prototype unimproved channel sections and to those used in theoretical computations on which the design of channel improvements was based. Roughness values used in the prototype design were 0.025 for riprapped surfaces, 0.030 for earth sections, and 0.018 for paved sections of the channels. Corresponding model roughness values were 0.0126, 0.0152, and 0.0091, respectively. A series of tests was undertaken in a special test reach of the model to determine the texture required on the model surfaces to simulate the design prototype roughness values. Upon conclusion of these tests, the various channel sections of the model were coated with the degree of roughness indicated by the test results. A test was then undertaken to determine the ability of the model to reproduce the computed water-surface profiles of the initial plan of improvement. Model and computed water-surface profiles were in close agreement through reaches of uniform channel sections thus indicating that proper roughness values prevailed in the model (plates 1 and 2).

PART III: NARRATIVE OF TESTS

Test Procedure

20. All tests were conducted with constant stages established in the model. The desired inflows were set, water-surface elevations in the lower reaches of the model adjusted by operation of the tailgates, and the model permitted to stabilize prior to obtaining test data. Data obtained consisted of inflow and outflow measurements, water-surface elevations and velocity measurements, visual observations, and photographic records of flow conditions. Velocity measurements were obtained at mid-depths.

Test of Initial Improvement Plan

21. The purposes of testing the initial improvement plan were to check the hydraulic phenomena expected to result from this plan, and to establish a base or standard for comparison with results of subsequent tests of modifications of the initial improvement plan.

22. All elements of the initial improvement plan located within the model limits (paragraphs 6-10 and figure 3) were installed in the model and tested for the following inflows and outflows:

Inflow cfs	Outflow cfs
Farm Creek, 15,500	Farm Creek, 14,000
Kerfoot Creek, 3,900	Diversion channel, 8,000
Cole Creek, 2,600	

It was noted at the beginning of the tests that the diversion channel was discharging 7,500 cfs rather than the design flow of 8,000 cfs.

Therefore, Farm Creek below the diversion channel entrance was constricted to force an additional 500 cfs into the diversion channel, thus permitting direct comparison of model data with computed design data.

23. Water-surface elevations obtained along the center lines of the channels were in close agreement with computed elevations except in the vicinity of drop structures, control structures, channel obstructions, variable channel sections, and stream confluences (table 2, plates 1 and 2).

24. Velocities in the model areas representing unpaved prototype areas generally exceeded the 8.5-ft-per-sec design velocities. Velocities ranged from 7.4 ft per sec to 14.0 ft per sec in the unpaved areas of Farm Creek, from 6.4 to 9.5 ft per sec in the diversion channel, as high as 11.4 ft per sec in Cole Creek, and from 4.3 to 6.7 ft per sec in Kerfoot Creek (table 3).

25. The following undesirable local flow conditions were noted:

a. Superelevation of the water surface along the left bank at the entrance to the diversion canal resulted in submergence of the sub-structure of the highway bridge across the canal.

b. Standing waves created by the Peoria and Pekin Union Railroad bridge pier and abutments at sta 62+21 on Farm Creek caused partial submergence of the bridge sub-structure.

c. The drop structure on Cole Creek at sta 18+35 created standing waves which were amplified by downstream bends in the creek.

d. The protuberance in the left bank of Farm Creek just below the mouth of Cole Creek resulted in considerable disturbance in Farm Creek and backwater in Cole Creek.

e. Flow leaving the Farm Creek control structure at sta 116+00 was directed along the left bank of the unpaved area between the control section and the mouth of Kerfoot Creek (sta 106+00).

f. Channel alignment in the vicinity of the East Washington Street bridge at Farm Creek sta 100+68 caused a standing wave below the bridge and partial submergence of the bridge sub-structure by secondary waves upstream.

26. One purpose of the model investigation was to test the hydraulic performance of the various structures involved in the channel improvement plan and to correct any unsafe or undesirable conditions resulting from installation of these structures. Tests of the initial improvement plan indicated that considerable local improvements in flow conditions were desirable. Therefore, several tests of modified improvement plans were undertaken in the various problem areas simultaneously in order to expedite the study. However, each problem area was in effect an independent study, and is so treated in this report.

Tests of Diversion Channel and Entrance

27. Tests of the diversion channel were first undertaken to improve flow conditions at the channel entrance. However, it was soon apparent that if the diversion channel could be made to carry 12,500 cfs during the design flood of 22,000 cfs, improvements in the lower Farm Creek channel would not be necessary. Therefore, subsequent tests were directed toward interception of 12,500 cfs rather than the originally planned 8,000 cfs. The design flow of 22,000 cfs was used in all tests of the diversion channel.

Plan 1

28. The first modified plan tested to increase the efficiency of the diversion channel consisted of realigning the right bank of Farm Creek upstream from the Toledo, Peoria, and Western Railroad bridge

(plate 3). This revision resulted in an increase in the cross-sectional area between the right bank and the interceptor wall.

29. Realignment of the right bank of Farm Creek resulted in a natural diversion channel flow of 8,100 cfs. Standing waves created by the entrance channel configuration submerged portions of the sub-structure of the highway bridge immediately downstream. Water-surface elevations in the diversion channel were generally increased over those resulting in the test of the initial plan (table 4).

Plan 2

30. The second modified plan tested consisted of decreasing the length of the interceptor wall 115 ft from sta 0+00 to sta 1+15 and relocating the diversion sill at sta 1+15 (plate 3). Also, the right bank revision of plan 1 was retained.

31. The plan 2 revisions resulted in a natural diversion channel flow of 9,200 cfs accompanied by velocity and stage increases (tables 4 and 5). The stage increases resulted in greater submergence of the highway bridge than for plan 1 conditions.

Plan 3

32. The third modified plan (plate 3) consisted of further realignment of the right bank of Farm Creek to include a vertical wall extending 190 ft upstream from the diversion channel; realigning and increasing the length of the interceptor wall to sta 1+00; elimination of the diversion sill; installation of three 5-ft-high splitter walls in the diversion channel entrance; redesign of the diversion channel transitions downstream from the highway bridge, and enlargement and redesign of the diversion channel to provide a bottom width of 100 ft, 1-on-3 side slopes,

and a roughness value of 0.030 (prototype).

33. Tests with the enlarged diversion channel resulted in a diversion of 12,200 cfs from Farm Creek. An unstable hydraulic jump formed on the downstream side of the highway bridge, intermittently submerging the sub-structure of the bridge. Tables 4 and 5 show water-surface elevations and velocities obtained with the enlarged diversion channel.

34. Installation of three 5-ft-high splitter walls had no appreciable effect upon capacity of or flow conditions in the entrance channel.

Plan 4 (final design)

35. The results of tests of plan 3 indicated that the diversion channel could be made to carry 12,500 cfs of the design flow of 22,000 cfs, leaving 9,500 cfs to pass through the lower Farm Creek channel. Examination of discharge records and computations made thereon indicated that the lower Farm Creek channel in its present unimproved condition was capable of carrying 9,500 cfs with the required freeboard of 2 ft. Therefore, a series of preliminary tests was made with flows of 9,500 cfs in lower Farm Creek and 12,500 cfs produced in the diversion channel by arbitrarily constricting the lower Farm Creek channel. Under these conditions a water-surface elevation of 460.1* was obtained at sta 55+75 and flow conditions upstream were not adversely affected. The unimproved reach of Farm Creek immediately below the diversion channel, which constitutes a natural control as a result of side and bottom contraction, was then remolded. The improved channel below this control section was not remolded as it had no effect upon flow conditions upstream. Elements of plan 4 were then

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* All elevations used in this report are referenced to mean sea level.

installed in the model.

36. The fourth and final plan (plate 3 and figure 6) retained the following elements of plan 3: (a) realignment of the right bank of Farm Creek, (b) the enlarged diversion channel with roughness factor of 0.030, (c) the redesigned diversion channel transition walls downstream from the highway bridge, and (d) the redesigned interceptor wall. In addition, plan 4 included a 1-on-3 sloping extension to the interceptor wall, a redesigned transition in Farm Creek below the interceptor wall to effect a return to the original channel section, and a deflector wall in the

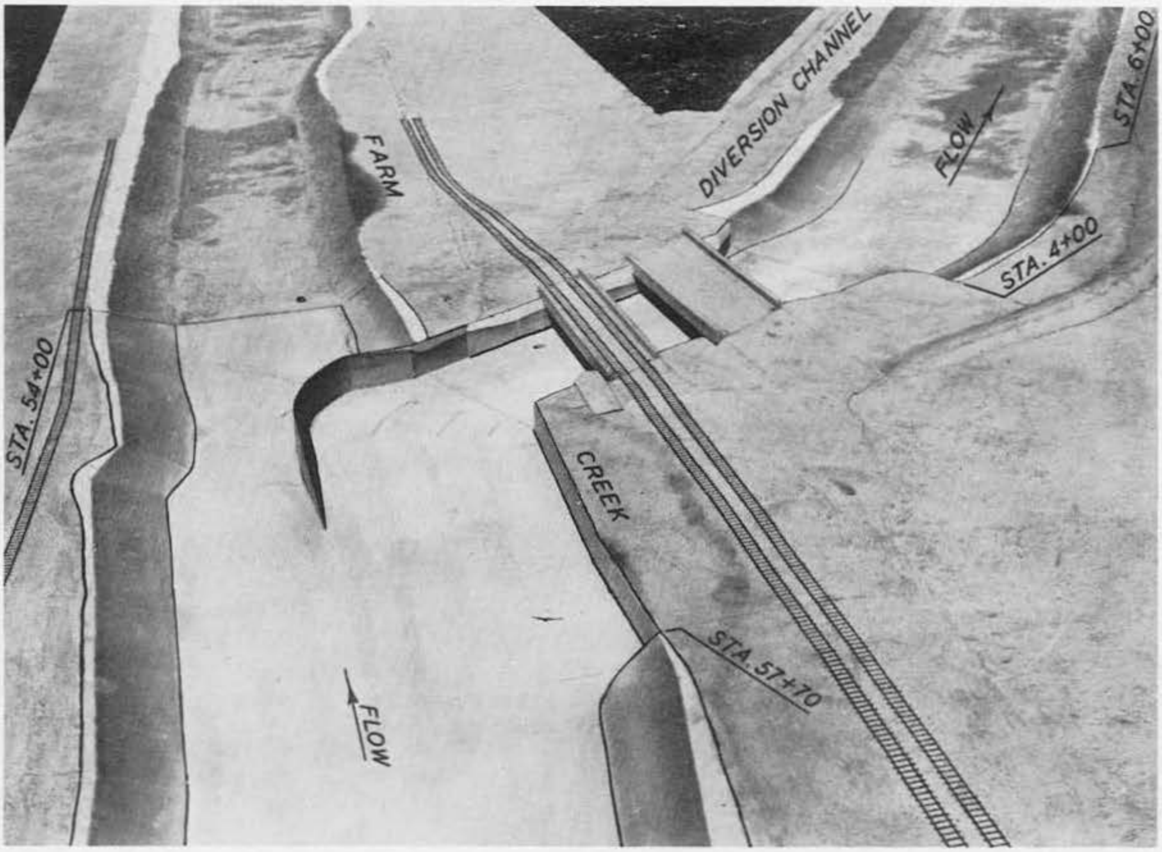


Fig. 6. Elements of the final plan, diversion channel entrance

diversion channel entrance to induce a downstream movement of the hydraulic jump resulting with plan 3 test conditions.

37. All primary tests of plan 4 were conducted with flows of 22,000 cfs and with water-surface elevations in the exit channels controlled by the configurations and roughnesses. Secondary tests were conducted to determine the division of flow and water-surface elevations for discharges other than the design flow of 22,000 cfs, and to determine the effects of high Illinois River stages on flow conditions in Farm Creek and in the diversion channel.

38. Installation of plan 4 in the model resulted in a natural flow of 12,500 cfs through the diversion channel with the remaining 9,500 cfs of the 22,000 cfs design flow carried by lower Farm Creek. Plate 4 is a graph showing the division of flows between Farm Creek and the diversion channel for various total flows. Water-surface elevations in the diversion channel and in Farm Creek above the diversion channel for the design flow with a low Illinois River stage are tabulated on table 4. Water-surface elevations in the lower Farm Creek channel are not tabulated as the improved channel of this reach was not installed in the model. The water-surface profile in the diversion channel for a flow of 12,500 cfs is shown on plate 5. A comparable profile for a flow of 9,500 cfs in Farm Creek immediately below the diversion channel is shown on plate 6.

39. Velocities in the diversion channel for a flow of 12,500 cfs ranged from 13.9 ft per sec at sta 3+37 to 7.0 ft per sec at sta 36+15 (table 5). Velocities in the upper reach of the diversion were increased 30 to 40 per cent over those of the test of the initial improvement plan, while those in the lower reach were decreased about 30 per cent. The maximum velocity of 13.9 ft per sec was in the paved channel under the highway bridge.

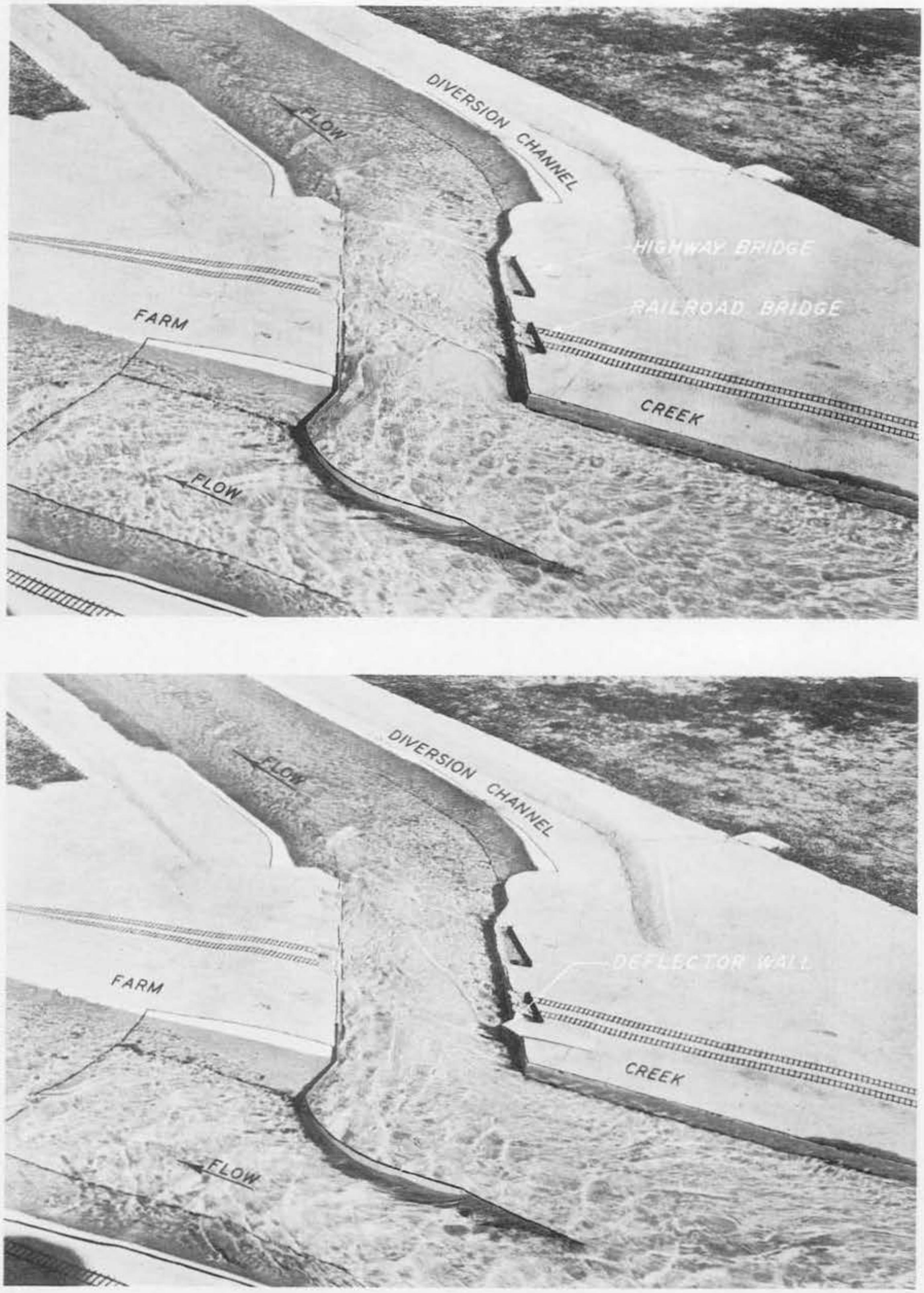


Fig. 7. Flow conditions in final plan diversion channel entrance without (above) and with deflector wall. Discharge in diversion channel, 12,500 cfs

40. Flow conditions under the highway bridge spanning the diversion channel without the deflector wall installed (plate 3, plan 4) were similar to those noted for plan 3 conditions. A hydraulic jump formed at the downstream end of the bridge intermittently submerging the sub-structure of the bridge. Installation of the deflector wall caused the jump to form downstream from the bridge. Figure 7 shows flow conditions without and with the deflector wall.

41. The results of tests (plate 7) made to determine the effects of high Illinois River stages on flow conditions in Farm Creek and the diversion channel show that Illinois River stages between 448 and 458 ft generally raised stages in the diversion channel. A stage of 456 ft submerged the sub-structure of both the highway bridge and the railroad bridge. The submergence of the sub-structures of the bridges across the diversion channel as a result of high Illinois River stages was accompanied by a 400-cfs reduction in channel capacity (12,500 cfs to 12,100 cfs) with a comparable increase in flow in Farm Creek (9,500 cfs to 9,900 cfs).

Cole Creek Tests

42. Details of improvement plans to increase the capacity of Cole Creek from 2,000 cfs to 3,600 cfs are discussed in paragraph 9 and shown on plate 8. Results of the test of the initial improvement plan (2,600-cfs Cole Creek flow) indicated certain adverse flow conditions. These adverse conditions consisted of standing waves generated by the drop structure located at sta 18+35 and amplified by the bends downstream so that they continued until merged with unstable flow below the confluence of Cole and Farm Creeks. The unstable flow below the mouth of Cole

Creek resulted from malalignment of the confluence which in turn caused large waves at and upstream from the Main Street bridge and backwater in Cole Creek (paragraph 25d). Redesign of the drop structure and realignment of the stream confluence were undertaken to effect improvements in these conditions.

43. Redesign of the drop structure at sta 18+35 comprised replacement of the angular training walls by curved training walls having radii of 25 ft, and extension of the rectangular 22-ft-wide channel section upstream to the top of the structure. The natural channel above the structure was reshaped to have 1-on-3 side slopes (plate 8 and figure 8). The protuberance at the confluence was removed and Farm Creek widened to effect a uniform transition from 80 ft to 110 ft in the vicinity of Cole Creek (plate 8 and figure 9).

44. The redesigned drop structure eliminated the standing waves between the drop structure and sta 16+00 and reduced velocities about 50 per cent in the unpaved section upstream from the drop structure. However, standing waves began to form in the first bend downstream at sta 16+00, increased in size in the bend at sta 11+00 and continued downstream until they were damped by backwater from Farm Creek.

45. Channel realignment at the confluence of Farm and Cole Creeks eliminated the large waves at and upstream from the Main Street bridge with a resulting reduction in water-surface elevations at the bridge (sta 68+50) of about two feet (table 2 and plate 6).

46. The above improvements in Cole Creek were investigated with the Farm Creek design flood, which provides for a flow of only 2,600 cfs in Cole Creek. Since the Cole Creek design flow is 1,000 cfs higher,

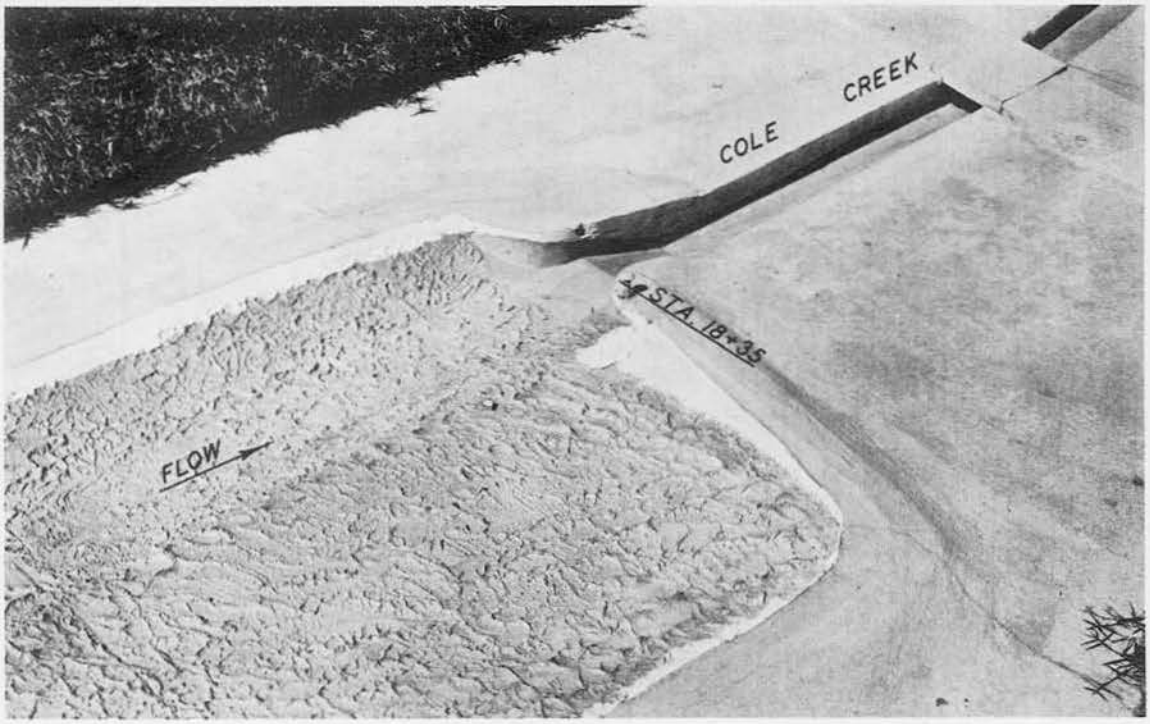


Fig. 8. Final plan for Cole Creek drop structure

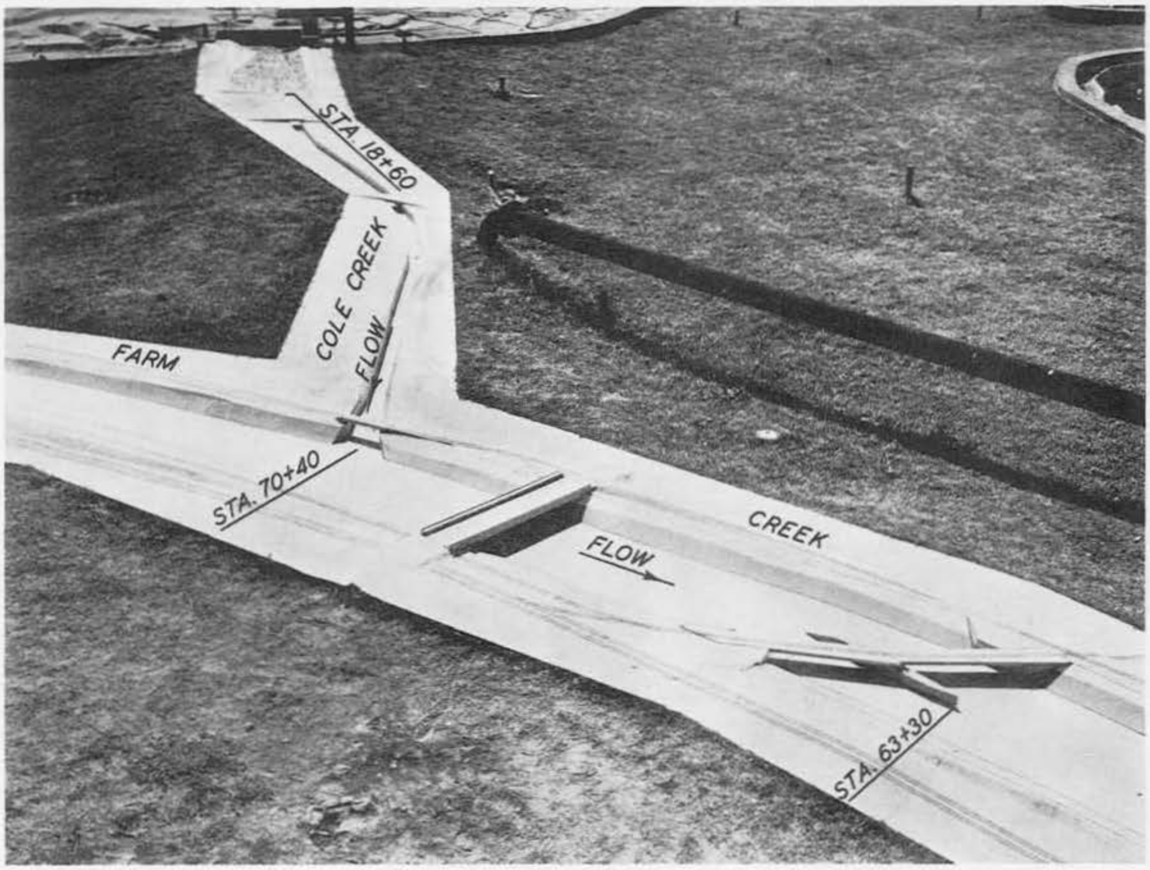


Fig. 9. Center reach of Farm Creek; note uniform transition in vicinity of Cole Creek

the improvements therein were also tested with a Cole Creek flow of 3,600 cfs. Farm Creek and Kerfoot Creek flows for this test were 9,800 cfs and 5,300 cfs, respectively. Water-surface elevations observed in Cole Creek for this combination of flows are shown in comparison with proposed retaining wall elevations in table 6. Examination of this table will show the need for increasing the wall height between sta 0+00 and sta 2+00 to provide the desired 2-ft freeboard.

Farm Creek Control Structure Tests (Sta 116+00)

47. The Farm Creek control structure (figure 10) at sta 116+00 as originally designed resulted in concentration of flow along the unpaved left bank between sta 106+00 and 115+00 (paragraph 25e). Four modified control structure plans were tested in the model to improve flow

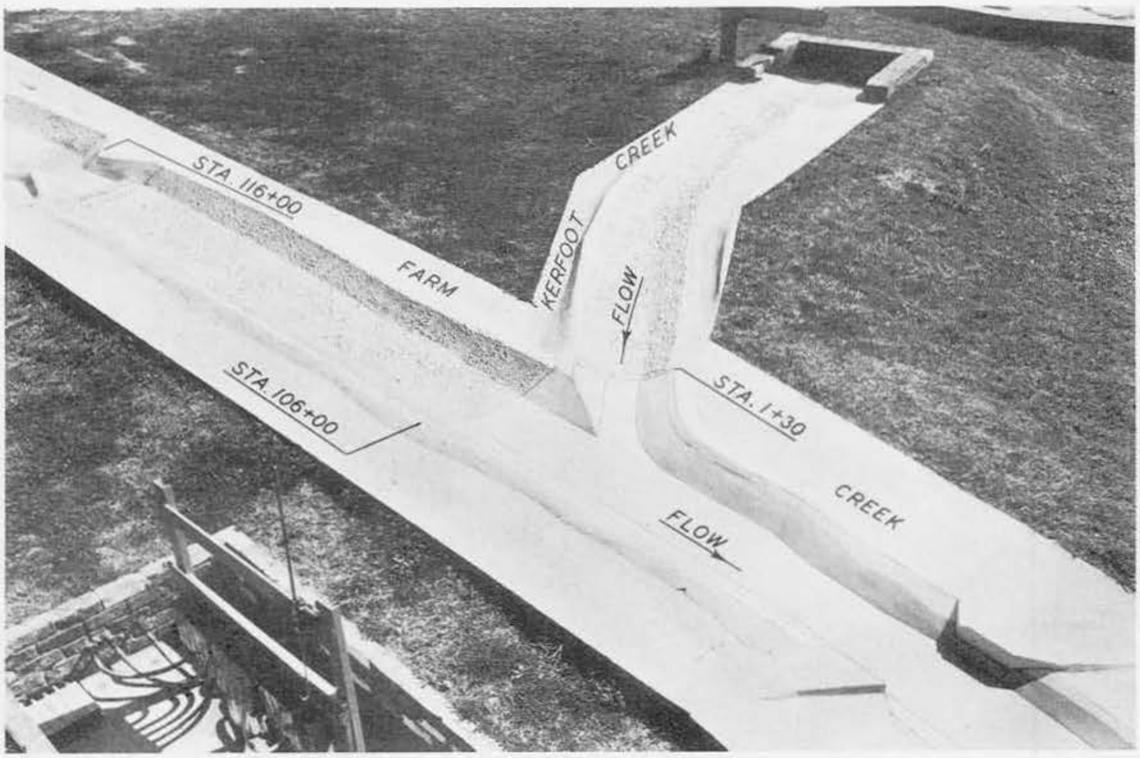


Fig. 10. Upper reach of Farm Creek

distribution in this area.

48. Modifications to the control structure were made to determine the optimum height and location of the end sill (plate 9). No changes were made upstream from the control section. All tested modifications retained an end sill elevation of 466.1 ft with heights of end sills varying from 3 to 10 ft. The end sill was located at sta 115+00 except in tests of plan 2 in which it was located at sta 114+70. A Farm Creek discharge of 15,500 cfs was used for testing end sill requirements.

49. Test results showed that the 7-ft end sill (plan 4) produced optimum flow conditions, generally reduced velocities in the unpaved section downstream, and eliminated the concentration of flow along the left bank between sta 106+00 and 115+00 (plate 9, tables 7 and 8, and figure 11).

Fig. 11. Flow conditions, final plan for Farm Creek control structure at sta 116+00, discharge 15,500 cfs

Farm Creek Channel Realignment Tests

50. Results of the test of the initial improvement plan showed that the proposed Farm Creek channel alignment in the vicinity of the East Washington Street bridge resulted in undesirable flow conditions (paragraph 25f). Two alternate channel plans (plate 10) were tested to effect improvements.

51. The first alternate, plan 1, involved the use of warped channel slopes extending upstream and downstream from the bridge abutments. The second alternate, plan 2, involved the use of uniformly sloping channel banks throughout the problem area. A flow of 19,400 cfs was used in testing these improvement plans.

52. Test results indicated that both plans were equally effective in eliminating the standing waves between sta 98+00 and 102+50, thereby providing the required clearance under the bridge (plate 10). However, plan 1 was discarded because of expected construction difficulties.

Peoria and Pekin Union Railroad Bridge Tests

53. Tests of the Peoria and Pekin Union Railroad Bridge were concerned with the elimination of the waves (paragraph 25b) created by the bridge abutments and pier. The plan involved an upstream and a downstream extension of the bridge pier. The upstream extension was 67.1 ft long and included a 37.1-ft rounded nose on a 3-on-1 slope; the downstream extension was 55 ft long and included a 30-ft, triangular-shaped nose. A 3.5-ft-high cap was added to the upstream extension

to prevent wave wash. Various changes in alignment of the bridge abutments were made with the pier extensions installed to assist in elimination of the troublesome waves. The final abutment design involved 25-ft and 22.5-ft upstream extensions of the right bank and left bank abutments, respectively (see plate 11 and figure 12). All tests were conducted with a discharge of 22,000 cfs.

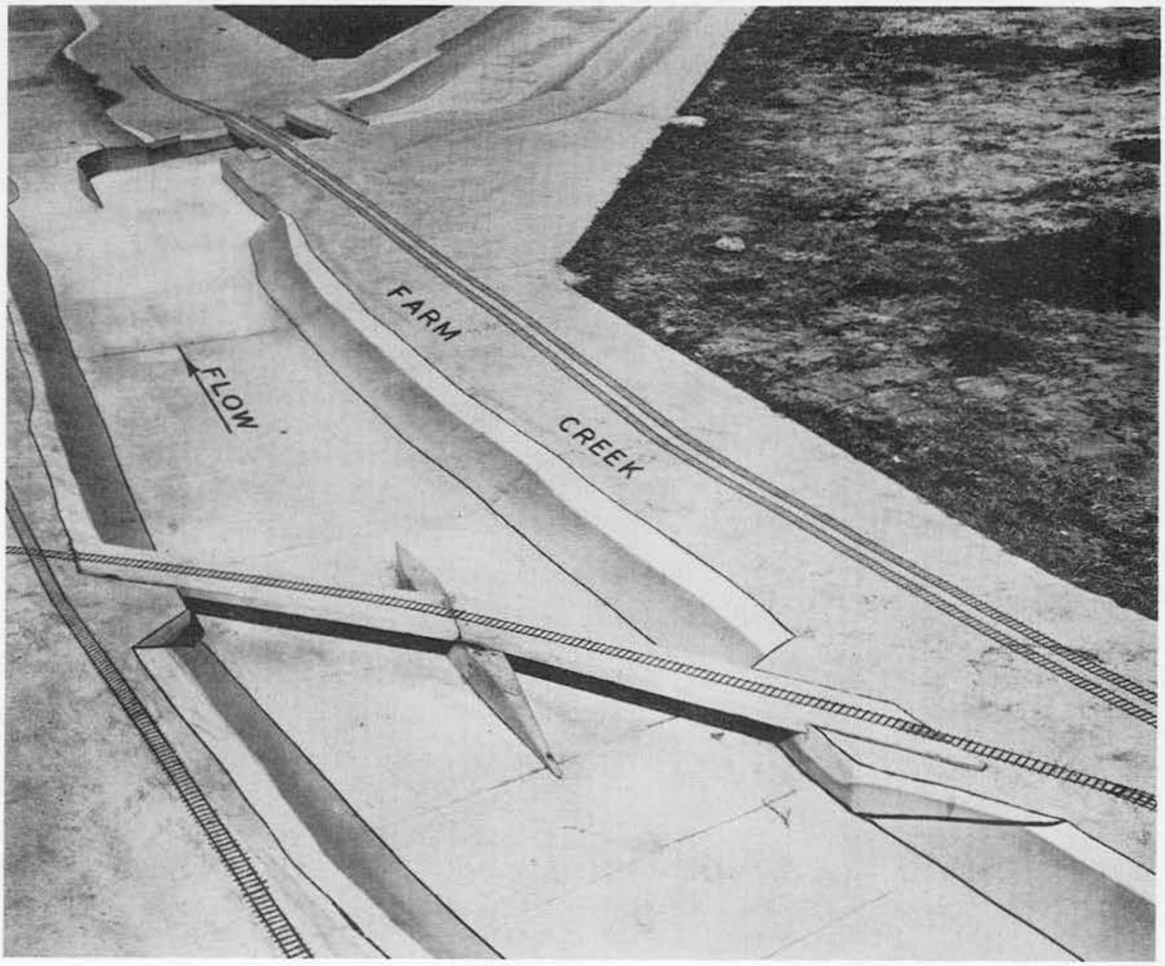


Fig. 12. Final pier and abutment plan for Peoria and Pekin Union Railroad bridge

54. The redesigned bridge abutments and pier eliminated the large waves immediately above and below the bridge as well as the waves under

the bridge which were submerging the sub-structure (figure 13). In

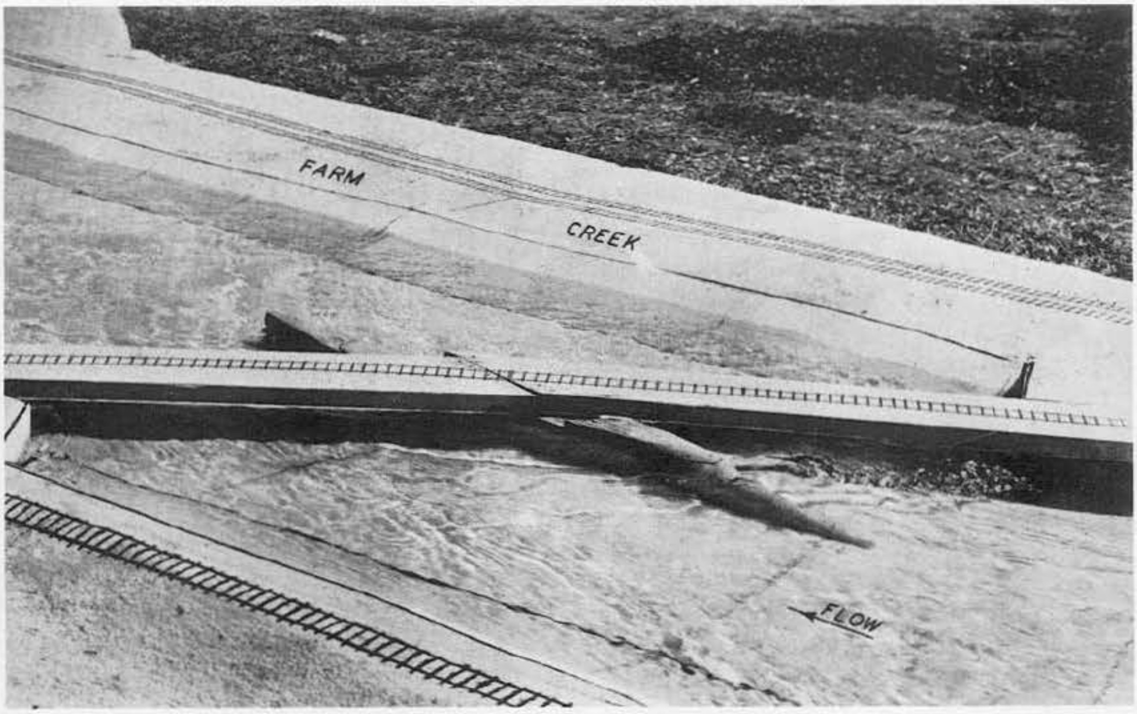


Fig. 13. Flow conditions, final pier and abutment plan for Pekin Union Railroad bridge; discharge 22,000 cfs

addition, a general lowering of water-surface elevations in the problem area was obtained (tables 9 and 10).

PART IV: CONCLUSIONS AND RECOMMENDATIONS

55. Model tests of the Farm Creek improvement plan revealed that while performance of the plan as originally designed was generally satisfactory, certain modifications would further improve the performance and at the same time effect economies in construction costs. These modifications, which are recommended for inclusion in the final design, are summarized below:

- a. Redesign of the entrance to the diversion channel (plan 4, paragraphs 35 through 41) to provide for an increase in diversion channel discharges from 8,000 cfs to 12,500 cfs. This alteration, which proved satisfactory in the model tests, would eliminate the necessity for improving the Farm Creek channel below sta 54+00.

- b. Redesign of the drop structure in Cole Creek and realignment of the Cole Creek channel at its confluence with Farm Creek (paragraphs 42 to 46) to provide better flow conditions in Cole Creek and to eliminate undesirable waves upstream from the Main Street bridge.

- c. Redesign of the Farm Creek control structure at sta 116+00 (plan 4, paragraphs 47 through 49) to provide a 7-ft end sill thereby reducing velocities in the unpaved section downstream.

- d. Realignment of the channel in the vicinity of the East Washington Street bridge (plan 2, paragraphs 50 through 52) to eliminate standing waves between sta 98+00 and 102+50, thereby providing the necessary clearance under the bridge.

- e. Redesign of the Peoria and Pekin Railroad bridge abutments and piers (paragraphs 53 and 54) to eliminate standing waves and to provide better flow conditions under the bridge.

TABLES

Table 1

PERMANENT GAGE LOCATIONS*

Gage No.	Station No.	Remarks
	Farm Creek	
1	123 + 49.6	Center of channel
2	119 + 60.6	Center of channel
3	116 + 69.6	Center of channel
4	116 + 15.6	Center of channel
5	113 + 90.6	Center of channel
6	110 + 44.2	Center of channel
7	105 + 61.2	Center of channel
8	102 + 72.2	Center of channel
9	102 + 22.2	Center of channel
10	100 + 72.2	Center of channel
11	99 + 00.8	Center of channel
12	92 + 08.8	Left edge of channel
13	92 + 08.8	Right edge of channel
14	84 + 21.2	Left edge of channel
15	84 + 21.2	Right edge of channel
16	76 + 30.0	Left edge of channel
17	76 + 30.0	Right edge of channel
18	71 + 42.7	Center of channel
19	69 + 77.7	Center of channel
20	65 + 72.7	Center of channel
21	64 + 51.7	Left edge of channel
22	64 + 51.7	Right edge of channel
23	61 + 72.7	Center of channel
24	59 + 44.7	Center of channel
25	56 + 54.1	Center of channel
26	53 + 99.1	Center of channel
27	48 + 02.1	Center of channel
28	40 + 49.5	Center of channel
29	34 + 40.5	Center of channel
30	28 + 29.1	Center of channel
31	20 + 49.3	Left edge of channel
32	20 + 49.3	Right edge of channel
33	17 + 63.3	Center of channel
34	16 + 34.3	Center of channel
35	13 + 31.1	Center of channel
36	10 + 37.1	Center of channel
37	5 + 70.0	Center of channel
38	0 - 78.0	Center of channel

(Continued)

* See fig. 3.

Table 1 (Continued)

Gage No.	Station No.	Remarks
	Diversion Channel	
D-1	37 + 00.0	Center of channel
D-2	30 + 75.0	Center of channel
D-3	24 + 96.0	Center of channel
D-4	18 + 72.0	Center of channel
D-5	13 + 02.0	Center of channel
D-6	7 + 02.0	Center of channel
D-7	4 + 14.0	Right edge of channel
D-8	4 + 14.0	Left edge of channel
D-9	1 + 56.0	Right edge of channel
D-10	1 + 56.0	Left edge of channel
D-11	1 + 45.0	Left edge of channel
D-12	0 + 61.0	Center of channel
	Cole Creek	
C-1	22 + 70.0	Center of channel
C-1A	19 + 00.0	Center of channel
C-1B	18 + 50.0	Center of channel
C-2	17 + 00.0	Center of channel
C-3	12 + 00.0	Center of channel
C-4	7 + 20.0	Center of channel
C-5	1 + 50.0	Center of channel
C-6	0 + 40.0	Center of channel
	Kerfoot Creek	
K-1	9 + 17.0	Center of channel
K-2	4 + 82.0	Center of channel
K-3	1 + 10.0	Center of channel

Table 2

WATER-SURFACE ELEVATIONS

Inflow

Farm Creek, 15,500 cfs
Kerfoot Creek, 3,900 cfs
Cole Creek, 2,600 cfs

Outflow

Initial Plan
Farm Creek, 14,000 cfs
Diversion Channel, 8,000 cfs

Final Plan
Farm Creek, 9,500 cfs
Diversion Channel, 12,500 cfs

Gage No.* or Sta	Elevation in Feet msl: Initial Plan, Computed**	Elevation in Feet msl: Initial Plan, Model	Elevation in Feet msl: Final Plan, Model
	Farm Creek		
1	481.5	482.1	482.0
2	481.2	481.1	481.3
3	481.4	481.3	481.5
4	478.4	480.2	480.5
Sta 114 + 83.0	477.4	475.7	
5	477.4	475.3	477.7
Sta 112 + 21.0	477.2	475.5	
6	477.0	475.9	477.7
Sta 108 + 32.0	468.8	476.0	
7	476.4	475.7	477.2
8	474.8	473.8	475.9
9	473.5	473.3	475.2
Sta 101 + 48.0	470.4	472.5	473.3
10	470.2	470.8	470.2
Sta 99 + 35.0	469.7	466.8	
11	469.6	467.8	469.0
Sta 98 + 72.0	469.5	471.8	
Sta 98 + 36.0	469.4	469.7	
12	467.6	466.5	466.8
13	467.6	466.9	467.1
14	465.2	465.5	466.4
15	465.2	465.9	466.4
16	462.9	462.2	461.6
17	462.9	462.2	462.2
Sta 75 + 95	462.8	462.3	461.8

(Continued)

* See table 1 and fig. 3 for gage locations.
** Obtained from profiles supplied by Chicago District.

Table 2 (Continued)

Gage No.* or Sta	Elevation in Feet msl: Initial Plan, Computed**	Initial Plan, Model	Final Plan, Model
	Farm Creek (Cont'd)		
Sta 72 + 00	462.3	462.8	463.0
18	462.2	463.0	462.8
Sta 71 + 18	462.0	463.0	464.0
19	460.8	458.7	459.5
Sta 68 + 85	461.0	462.4	460.5(2)
Sta 68 + 25	461.1		460.6(3)
20	461.0	458.8	459.7
21	461.6	461.0(1)	459.7
22	461.6	460.4(1)	459.4
Sta 64 + 75	461.4		461.0(4)
Sta 64 + 65	461.4	464.7	
Sta 64 + 49	461.6		458.9(6)
Sta 64 + 49	461.6		459.9(7)
Sta 64 + 33	461.5	464.7	
Sta 64 + 27	461.4		456.6(8)
Sta 64 + 00	461.0		460.1(9)
Sta 63 + 57	460.6		457.1(10)
Sta 63 + 54	460.5		459.0(11)
Sta 63 + 22	460.4		457.8(12)
23	459.5	459.5	458.9
24	459.0	457.3	458.3
Sta 57 + 20	458.6	458.6	
25	456.6	457.7	459.9
26	458.0	456.8	460.8
Sta 52 + 99	457.9	457.0	
27	457.4	457.3	454.0(5)
28	456.4	456.2	
29	455.7	455.6	
30	455.0	454.8	
31	454.1	453.7	
32	454.1	453.5	
Sta 18 + 12	453.9	453.2	
33	450.9	452.7	
Sta 16 + 92	451.7	450.0	
34	451.7	449.8	
Sta 15 + 75	451.4	452.1	

(Continued)

See notes at end of table for numbers in parentheses.

* See table 1 and fig. 3 for gage locations.

** Obtained from profiles supplied by Chicago District.

Table 2 (Continued)

Gage No.* or Sta	Elevation in Feet msl: Initial Plan Computed**	Initial Plan Model	Final Plan Model
	Farm Creek (Cont'd)		
Sta 14 + 20	450.3	453.6	
35	450.0	449.3	
Sta 12 + 64	449.6	449.4	
Sta 11 + 63	450.4	449.9	
Sta 11 + 20	449.7	449.0	
36	449.6	449.3	
37	449.1	449.3	
38	448.0	448.0	
	Diversion Channel		
D-1	450.1	450.6	452.0
D-2	452.1	452.3	452.9
D-3	453.4	453.3	453.5
D-4	454.8	455.0	454.4
D-5	455.7	455.8	455.6
D-6	456.8	456.4	455.9
D-7	457.3	456.4	455.1
D-8	457.3	456.4	455.3
D-9	451.9	455.1	453.5
D-10	451.9	454.7	456.4
D-11	452.2	459.2	460.4
D-12	454.7	455.6	459.7
	Cole Creek		
C-1	477.6(13)	477.4	478.2
C-1-A	476.6	473.7	477.3
C-1-B	474.0	473.0	477.0
C-2	466.2	461.6	461.5
C-3	460.0	463.4	462.2
C-4	461.8	463.4	462.8
C-5	460.3	463.6	463.1
Sta 1 + 05	461.1		
C-6	461.1	464.0	463.4

(Continued)

See notes at end of table for numbers in parentheses.

* See table 1 and fig. 3 for gage locations.

** Obtained from profiles supplied by Chicago District.

Table 2 (Continued)

Gage No.* or Sta	Elevation in Feet msl		
	Initial Plan		Final Plan
	Computed**	Model	Model
	Kerfoot Creek		
K-1	475.3	475.9	477.4
K-2	475.2	475.8	477.2
K-3	475.2	475.6	477.1

(1) Within disturbance caused by bridge pier
(2) Upstream side Main Street bridge
(3) Downstream side Main Street bridge
(4) Upstream center P & PURR bridge
(5) Unimproved channel not installed in model below this gage
(6) Upstream right side of P & PURR bridge pier
(7) Downstream center right span P & PURR bridge
(8) Upstream left side P & PURR bridge pier
(9) Downstream right side P & PURR bridge pier
(10) Downstream center left span P & PURR bridge
(11) Upstream left abutment P & PURR bridge
(12) Downstream left abutment P & PURR bridge
(13) Extrapolated gages C-1 through C-4

* See table 1 and fig. 3 for gage locations.
** Obtained from profiles supplied by Chicago District.

Table 3

VELOCITY OBSERVATIONS

Initial Improvement Plan

Inflows	Outflows
Farm Creek, 15,500 cfs	Farm Creek, 14,000 cfs
Kerfoot Creek, 3,900 cfs	Diversion Channel, 8,000 cfs
Cole Creek, 2,600 cfs	

Station	Maximum Velocities*	Remarks
	Farm Creek	
2 + 46	7.8	Unpaved
9 + 00	11.0	Unpaved
21 + 65	9.4	Unpaved
34 + 00	8.2	Unpaved
43 + 60	8.8	Unpaved
50 + 80	12.2	Unpaved
54 + 00	14.6	Lower end of paving
90 + 06	15.0	Paved
107 + 00	12.6	Unpaved
112 + 00	14.0	Unpaved
115 + 00	16.3	Lower end of paving
118 + 25	7.4	Unpaved
121 + 25	10.2	Unpaved
	Diversion Channel	
3 + 37	10.8	Paved
6 + 15	6.8	Unpaved
12 + 15	6.4	Unpaved
19 + 65	7.4	Unpaved
27 + 15	9.4	Unpaved
36 + 15	9.5	Unpaved
	Cole Creek	
0 + 90	5.3	Paved
20 + 27	11.4	Unpaved
	Kerfoot Creek	
4 + 00	4.3	Unpaved
8 + 02	6.7	Unpaved

*Velocities are shown in ft per sec (prototype) and were taken at middepths.

Table 4

WATER-SURFACE ELEVATIONS

Diversion Channel Improvement Plans

Inflow	Outflow
Farm Creek, 15,500 cfs	Farm Creek, variable
Kerfoot Creek, 3,900 cfs	Diversion Channel, variable
Cole Creek, 2,600 cfs	

Diversion Channel	8,000 cfs	8,100 cfs	9,200 cfs	12,200 cfs	12,500 cfs
	Elevation in Feet msl				
Gage No.* or Sta	Initial Plan	Plan 1	Plan 2	Plan 3	Final Plan
			Farm Creek		
Gage 23	459.5	459.8	459.5	459.8	458.9
Gage 24	457.3	457.4	457.0	456.8	458.3
Sta 57 + 20	458.6		455.1		
Gage 25	457.7	457.9	457.6	458.8	459.9
Sta 55 + 52			454.2		
Sta 55 + 28			457.5		
Sta 54 + 80			456.8		
Gage 26	456.8	456.4	456.1	454.0	460.8
Gage 27	457.3	457.4	457.0	455.2	454.0
			Diversion Channel		
D-1	450.6	450.8	451.3	452.0	452.0
D-2	452.3	452.6	452.9	452.3	452.9
D-3	453.3	453.5	454.2	453.5	453.5
D-4	455.0	455.2	455.6	454.4	454.4
D-5	455.8	456.1	456.8	455.5	455.6
D-6	456.4	456.7	457.3	456.0	455.9
D-7	456.4	457.1	457.3	455.6	455.1
D-8	456.5	456.9	457.2	454.4	455.3
Sta 3 + 50		458.1	458.0		450.2
D-9	455.1	456.1	456.8	454.4	453.5
D-10	454.7	456.1	457.1	454.3	456.4
D-11	459.2	459.0	459.8	460.1	460.4
D-12	455.6	453.6	457.6	458.2	459.7

* See table 1 and fig. 3 for gage locations.

Table 5

VELOCITY OBSERVATIONS

Diversion Channel Improvement Plans

Inflow	Outflow
Farm Creek, 15,500 cfs	Farm Creek, variable
Kerfoot Creek, 3,900 cfs	Diversion Channel, variable
Cole Creek, 2,600 cfs	

Diversion Channel	8,000 cfs	9,200 cfs	12,200 cfs	12,500 cfs
	Maximum Velocities*			
Station	Initial Plan	Plan 2	Plan 3	Final Plan
	Diversion Channel			
3 + 37	10.8	12.9	13.9	13.9
6 + 15	9.7	9.8	11.4	10.1
12 + 15	6.4	7.1	8.3	8.8
19 + 65	7.4	8.1	8.3	8.5
27 + 15	9.4	9.5	7.5	7.0
36 + 15	9.5	10.2	7.0	7.0

* Velocities are shown in ft per sec (prototype) and were taken at mid-depths.

Table 6

WATER-SURFACE ELEVATIONS

Cole Creek Final Improvement Plan

Farm Creek, 9,800 cfs
Kerfoot Creek, 5,300 cfs
Cole Creek, 3,600 cfs

Farm Creek, 7,700 cfs
Diversion Channel, 11,000 cfs

Gage No.	Elev in Ft, msl	Proposed Top of Wall in Ft, msl	Freeboard in Ft
C-1	480.3	483.8	3.5
C-1A	479.9	483.5	3.6
C-1B	479.3	483.1	3.8
C-2	462.5	469.6	7.1
C-3	463.0	467.7	4.7
C-4	460.1	466.0	5.9
C-5	462.5	463.8	1.3
C-6	463.3	463.4	0.1

Note: Center-line station numbers of gages are shown in table 1.

Table 7

WATER-SURFACE ELEVATIONS

Farm Creek Control Structure Sta 116+00

Inflow

Farm Creek, 15,500 cfs
Kerfoot Creek, 3,900 cfs
Cole Creek, 2,600 cfs

Outflow

Farm Creek, variable
Diversion Channel, variable

Gage No.* or Sta	Initial Plan	Plan 1	Plan 2	Plan 3	Final Plan Plan 4
Gage 3	481.3	481.4	481.0	481.4	481.6
Gage 4	480.2	480.5	480.1	480.4	480.7
Sta 114 + 83.0	475.7	478.4	479.5	472.7	473.1
Gage 5	475.3	476.2	476.6	477.4	478.1
Sta 112 + 21.0	475.5	476.6	477.3	477.4	478.1
Gage 6	475.9	476.4	476.6	477.1	477.9
Sta 108 + 32.0	476.0				
Gage 7	475.7	475.8	475.8	476.2	477.9
Gage 8	473.8	473.8	473.9	474.3	477.2

* See table 1 and fig. 3 for gage locations.

Table 8

VELOCITY OBSERVATIONS

Farm Creek Control Structure Sta 116+00

Inflow	Outflow
Farm Creek, 15,500 cfs	Farm Creek, variable.
Kerfoot Creek, 3,900 cfs	Diversion Channel, variable.
Cole Creek, 2,600 cfs	

	Maximum Velocities*				
Station	Initial Plan	Plan 1	Plan 2	Plan 3	Final Plan Plan 4
			Farm Creek		
90 + 10	15.0	15.3			
99 + 35					14.9
107 + 50	12.6	10.2	10.2	10.2	7.0
112 + 00	14.0	12.9	8.5	8.3	8.3
115 + 00	16.3	16.9	15.5	13.9	15.5
118 + 25	7.4	7.8	8.3	8.3	6.5
121 + 25	10.2	10.5			

* Velocities are shown in ft per sec (prototype) and were taken at mid-depths.

Table 9

WATER-SURFACE ELEVATIONS

Tests of Extensions to P. & P.U.R.R. Bridge Pier, Farm Creek

Inflow

Farm Creek, 15,500 cfs
Kerfoot Creek, 3,900 cfs
Cole Creek, 2,600 cfs

Outflow

Farm Creek, 9,500 cfs
Diversion Channel, 12,500 cfs

Gage No.* or Sta	Elev in Ft, msl Initial Plan	Final Plan	Remarks
Gage 19	459.7	459.5	
Gage 20	459.3	459.7	
Sta 64 + 75	460.2	461.0	Upstream edge of bridge center of right span
Gage 21	461.0	459.7	
Gage 22	460.9	459.4	
Sta 64 + 49	463.1	458.9	Upstream edge of bridge at right side of pier
Sta 64 + 49	460.9	459.9	Downstream edge of bridge center of right span
Sta 64 + 27	458.7	456.6	Upstream edge of bridge near left side of pier
Sta 64 + 00	460.8	460.1	Downstream edge of bridge near right side of pier
Sta 63 + 57	459.2	457.1	Downstream edge of bridge center of left span
Sta 63 + 54	460.2	459.0	Upstream edge of bridge near left abutment
Sta 63 + 22	460.4	457.8	Downstream edge of bridge near left abutment
Gage 23	459.5	458.9	
Gage 24	457.3	458.3	

* See table 1 and fig. 3 for gage locations.

Table 10

WATER-SURFACE ELEVATIONS

Tests of Revisions to Abutments of P. & P.U.R.R. Bridge, Farm Creek

Inflow

Farm Creek, 15,500 cfs
Kerfoot Creek, 3,900 cfs
Cole Creek, 2,600 cfs

Outflow

Farm Creek, 9,500 cfs
Diversion Channel, 12,500 cfs

Gage No.* or Sta	Elevation in Ft, msl Plan 1**	Plan 2	Plan 3	Plan 4	Final Plan	Remarks
Gage 19	459.5	460.7	459.7	459.9	459.6	
Gage 20	458.8	461.6	458.6	461.7	460.0	
Sta 64+75	461.6	457.6	460.7	457.4	460.3	Upstream edge of bridge center of right span
Gage 21	459.0	459.5	459.2	459.5	459.8	
Gage 22	459.5	457.4	459.8	457.9	459.4	
Sta 64+49	461.0	458.6	459.9	458.9	459.9	Upstream edge of bridge near right side of pier
Sta 64+49		457.7	459.4	457.8	459.1	Downstream edge of bridge center of right span
Sta 64+27	457.6	458.4	457.3	457.9	458.1	Upstream edge of bridge near left side of pier
Sta 64+00	460.5	457.6	459.5	456.0	459.6	Downstream edge of bridge near right side of pier

(Continued)

* See table 1 and fig. 3 for gage location.
** Plan 1 is initial plan with extensions on P. & P.U.R.R. bridge pier installed.

Table 10 (Continued)

Inflow

Farm Creek, 15,500 cfs
Kerfoot Creek, 3,900 cfs
Cole Creek, 2,600 cfs

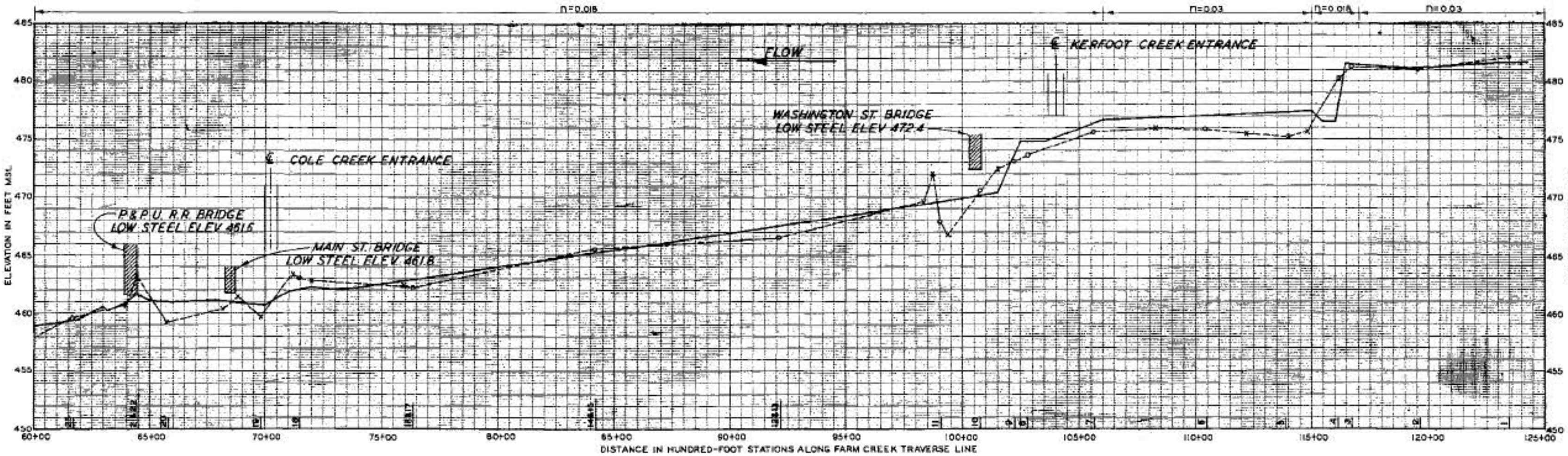
Outflow

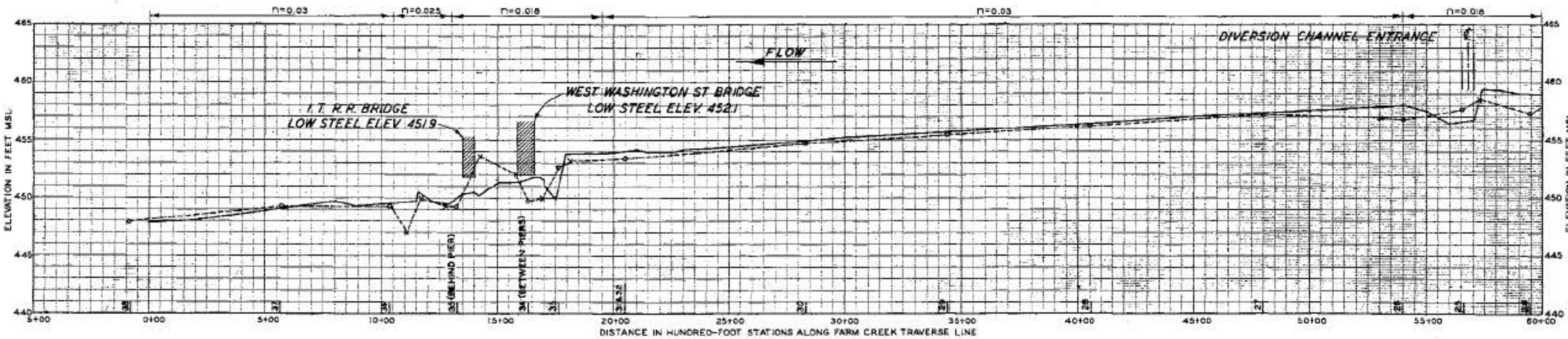
Farm Creek, 9,500 cfs
Diversion Channel, 12,500 cfs

Gage No.* or Sta	Elevation in Ft, msl					Remarks
	Plan 1**	Plan 2	Plan 3	Plan 4	Final Plan	
Sta 63+57	460.5	458.2	457.5	457.4	457.4	Downstream edge of bridge center of left span
Sta 63+54		459.5	458.6	458.8	458.8	Upstream edge of bridge near left abutment
Sta 63+22		457.6	458.3	457.1	458.2	Downstream edge of bridge near left abutment
Gage 23	459.3	459.7	459.7	459.7	459.1	
Gage 24	459.2	458.9	459.5	459.4	459.1	

* See table 1 and fig. 3 for gage location.
** Plan 1 is initial plan with extensions on P & P U R R bridge pier installed.

PLATES





LEGEND

- ——— COMPUTED WATER SURFACE PROFILE
- - - - - WATER SURFACE INITIAL PLAN
- o WATER SURFACE ELEVATIONS AT PERMANENT GAGES
- x WATER SURFACE ELEVATIONS AT TEMPORARY GAGES
- PERMANENT MODEL GAGES CENTER OF CHANNEL
- PERMANENT MODEL GAGES LEFT AND RIGHT EDGES OF CHANNEL RESPECTIVELY

TEST CONDITIONS

INFLOW		OUTFLOW	
FARM CREEK=	15,500 CFS	FARM CREEK=	14,000 CFS
KERFOOT CREEK=	3,900 CFS	DIVERISON CHANNEL=	8,000 CFS
COLE CREEK=	2,600 CFS		

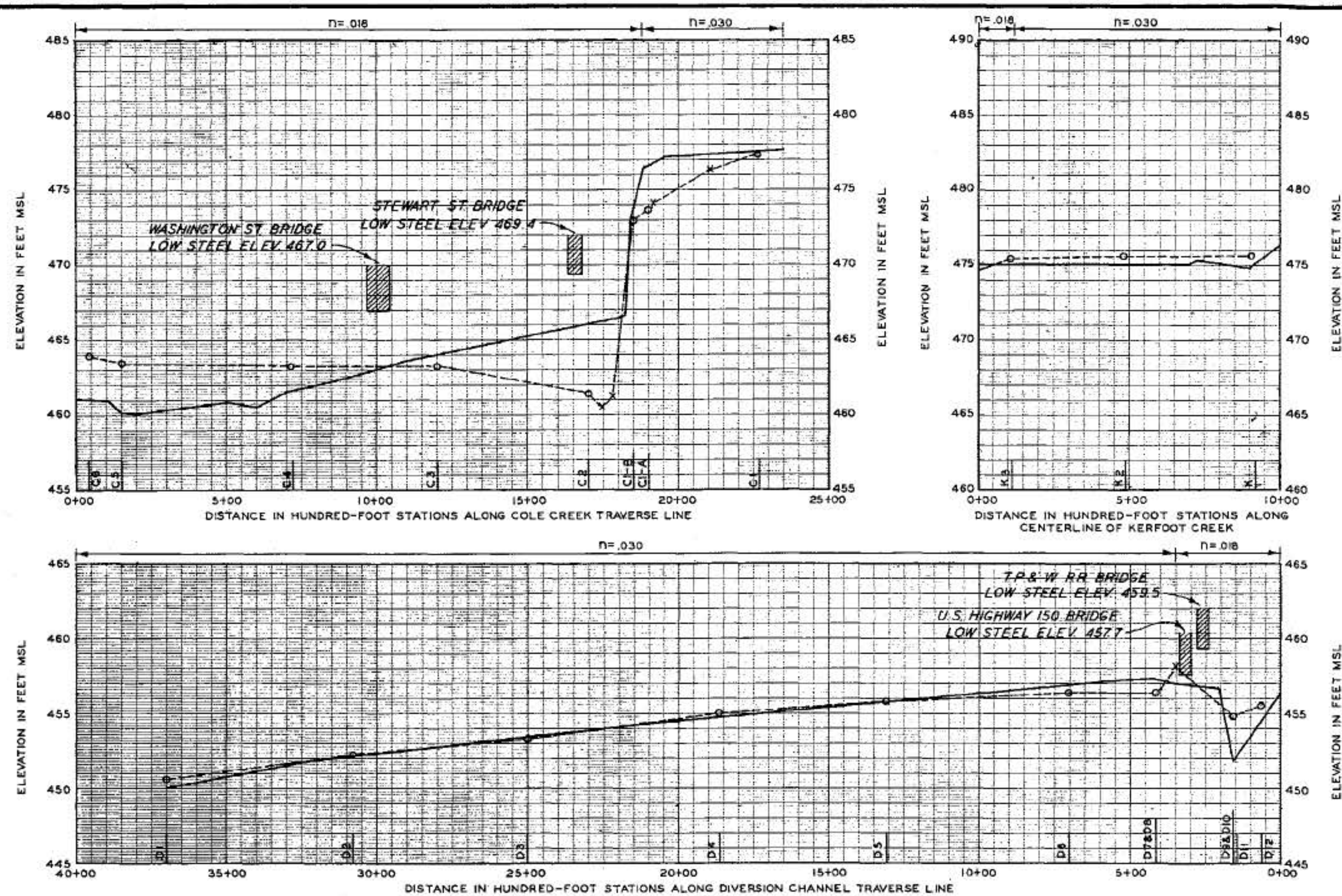
PROFILES ALONG CENTER LINE OF CHANNEL

INITIAL PLAN

FARM CREEK

PLATE 1

PLATE 2



- - - - - WATER-SURFACE PROFILE INITIAL PLAN

——— COMPUTED WATER-SURFACE PROFILE

o WATER-SURFACE ELEVATION AT PERMANENT GAGES

x WATER-SURFACE ELEVATION AT TEMPORARY GAGES

D4 PERMANENT MODEL GAGES CENTER OF CHANNEL

D7&D8 PERMANENT MODEL GAGES RIGHT AND LEFT EDGES OF CHANNEL RESPECTIVELY

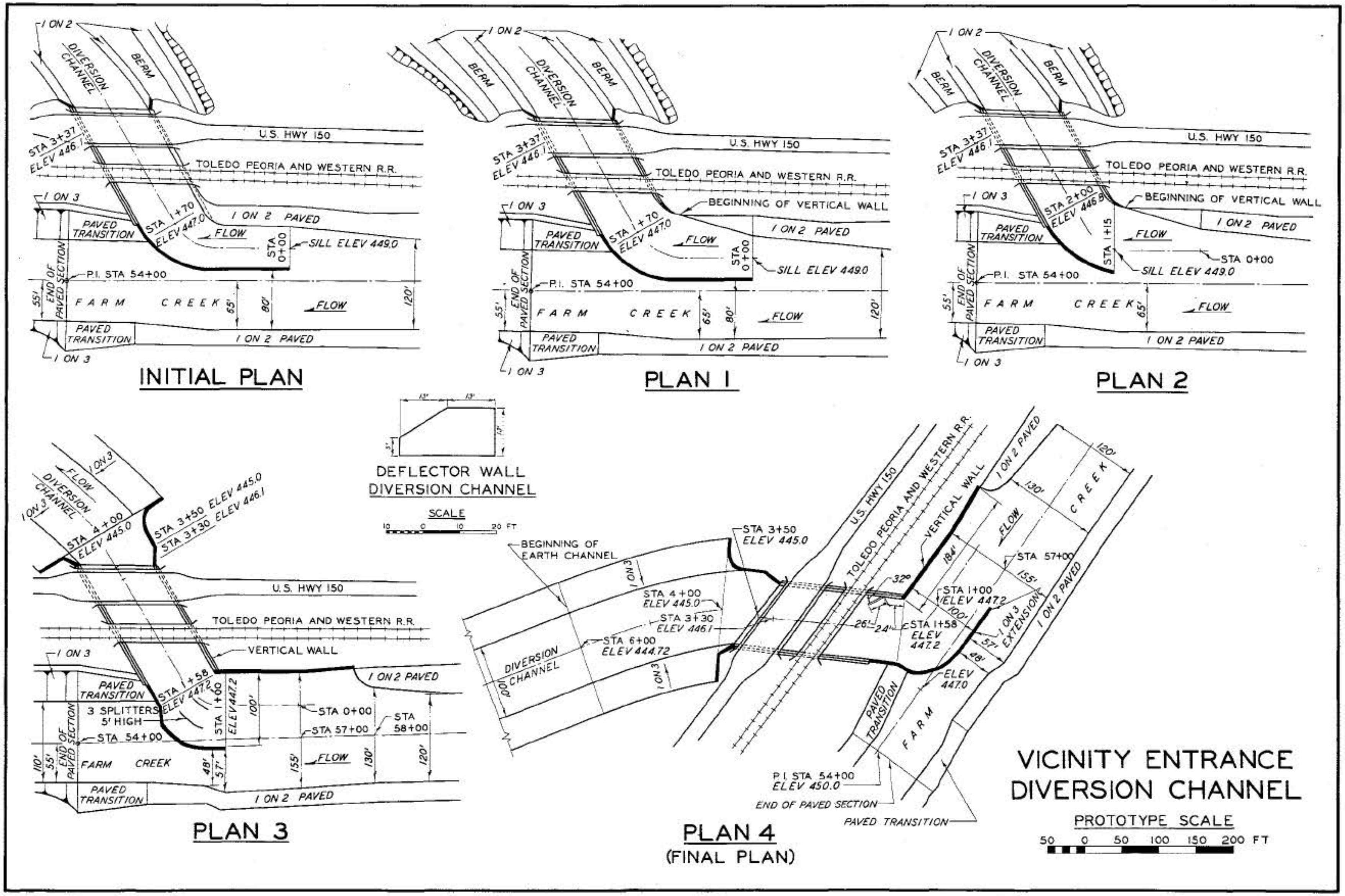
FLOW CONDITIONS

INFLOW		OUTFLOW	
FARM CREEK=	15,500 CFS	FARM CREEK=	14,000 CFS
KERFOOT CREEK	3,900 CFS	DIVERSION CHANNEL	8,000 CFS
COLE CREEK	2,600 CFS		

PROFILES ALONG CENTER LINE OF CHANNEL

INITIAL PLAN

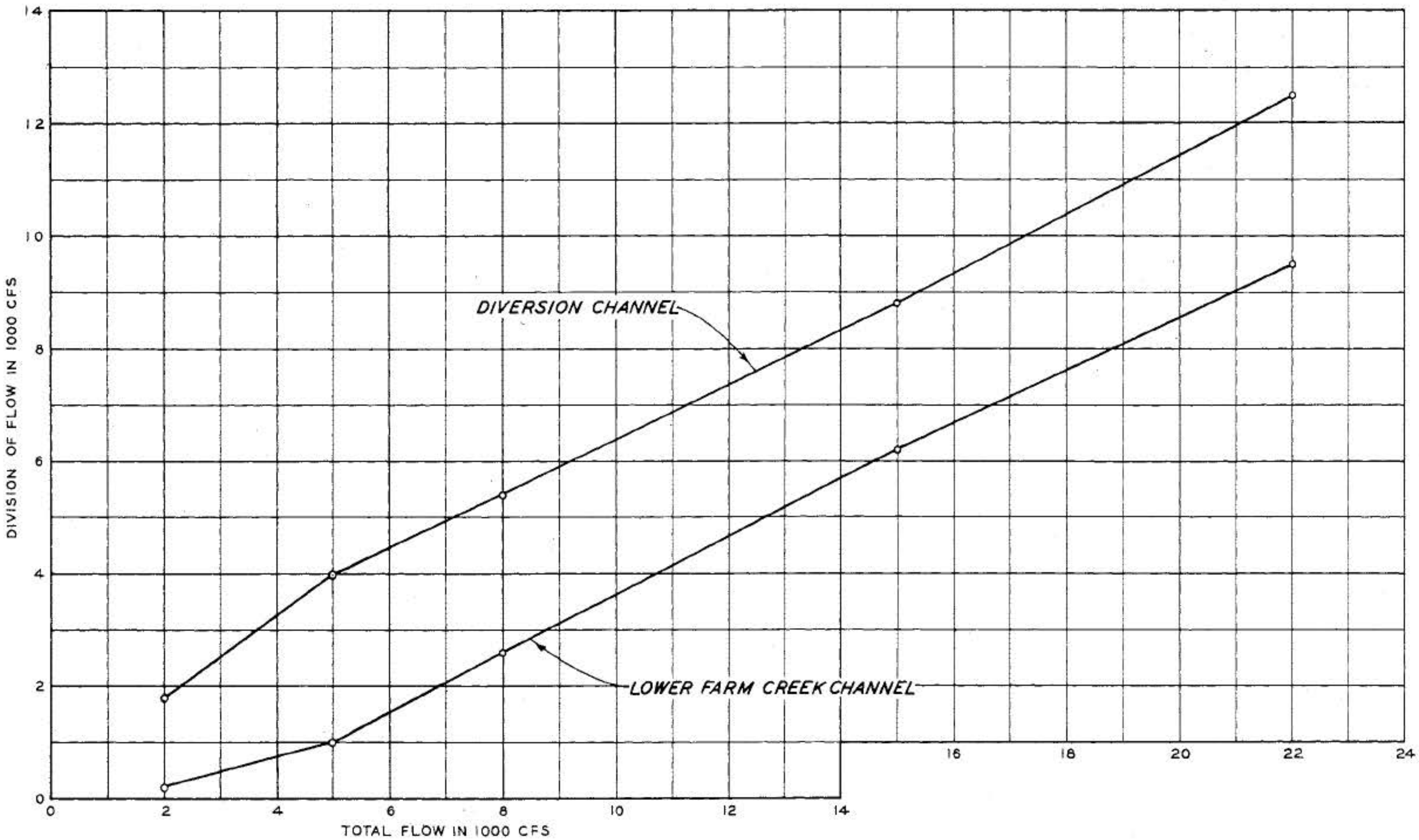
COLE AND KERFOOT CREEKS AND DIVERSION CHANNEL



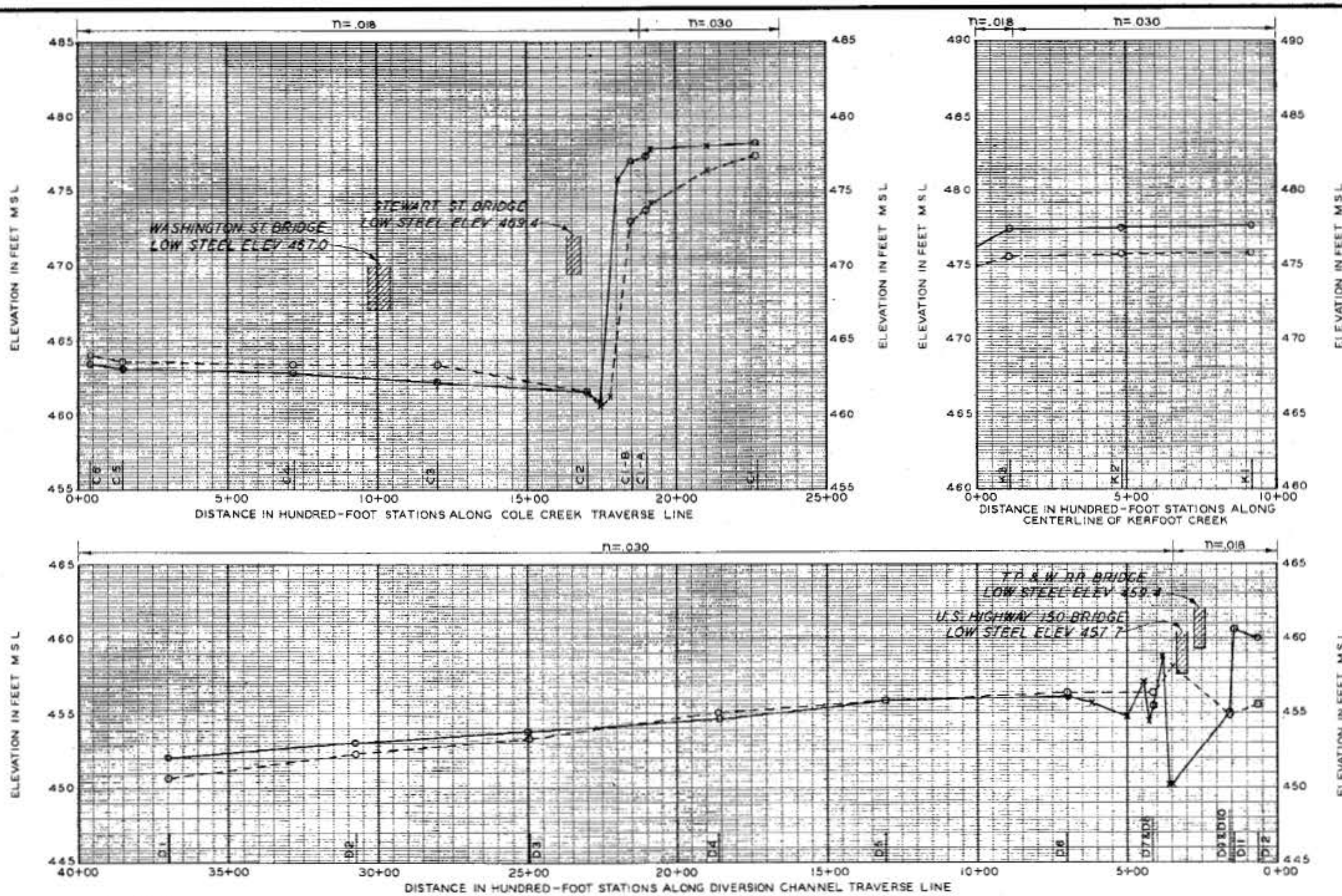
VICINITY ENTRANCE
DIVERSION CHANNEL

PLATE 3

PLATE 4



FARM CREEK-DIVERSION CHANNEL
DISCHARGE



LEGEND

- - - - WATER-SURFACE PROFILE INITIAL PLAN
—— WATER-SURFACE PROFILE FINAL PLAN
o WATER-SURFACE ELEVATION AT PERMANENT GAGES
x WATER-SURFACE ELEVATION AT TEMPORARY GAGES
D4 PERMANENT MODEL GAGES CENTER OF CHANNEL
D7 & D8 PERMANENT MODEL GAGES RIGHT AND LEFT EDGES OF CHANNEL RESPECTIVELY

FLOW CONDITIONS

INFLOW		OUTFLOW ORIGINAL DESIGN		FINAL DESIGN
FARM CREEK =	15,500 CFS	FARM CREEK =	14,000 CFS	9,500 CFS
KERFOOT CREEK =	3,900 CFS	DIVERSION CHANNEL =	6,000 CFS	12,500 CFS
COLE CREEK =	2,600 CFS			

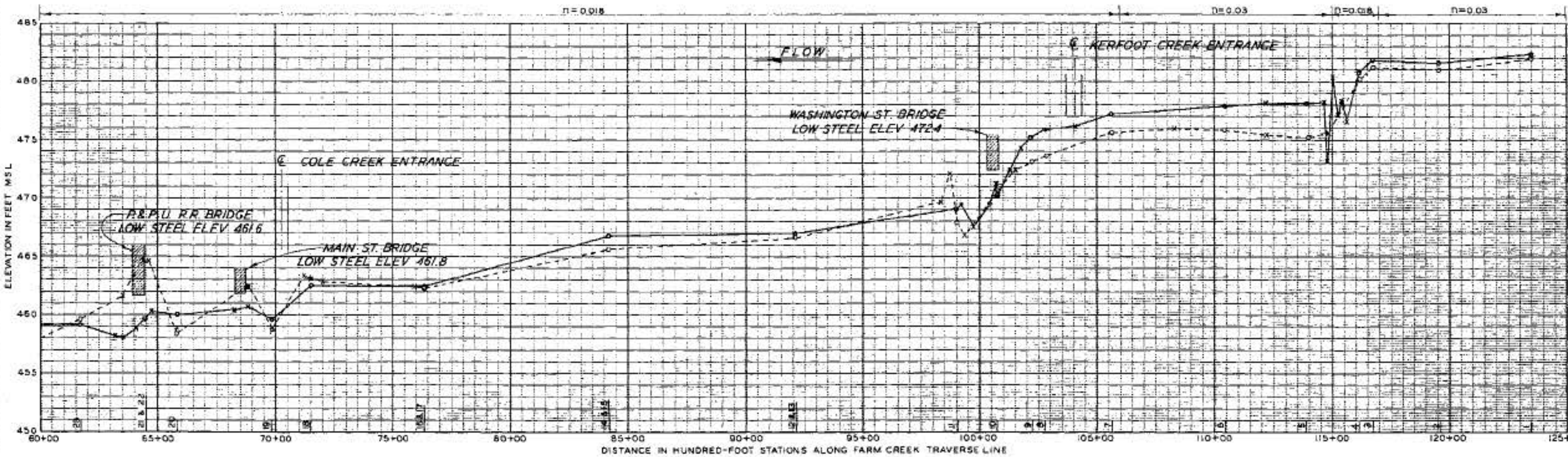
PROFILES ALONG CENTER LINE OF CHANNEL

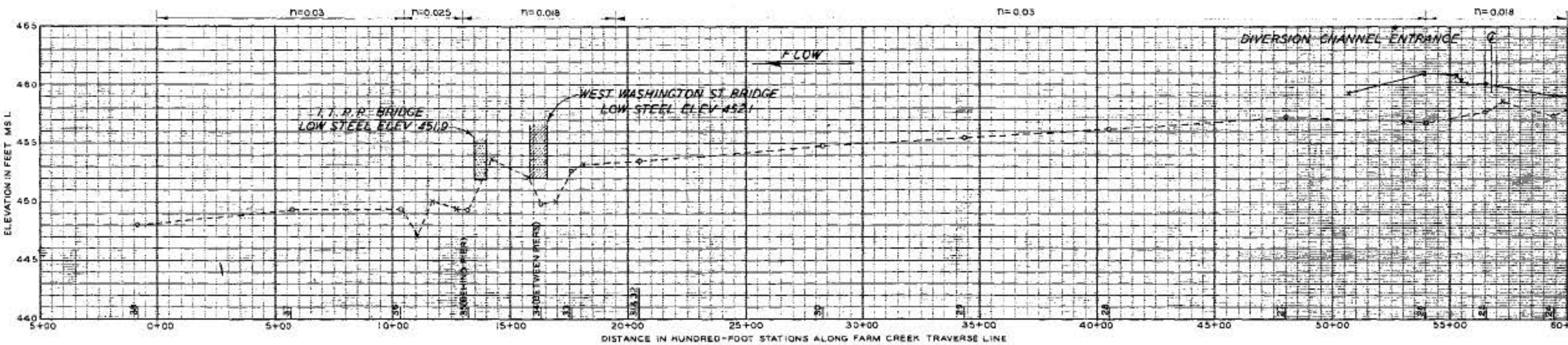
FINAL PLAN

COLE AND KERFOOT CREEKS AND DIVERSION CHANNEL

PLATE 5

PLATE 6





LEGEND

- ------ WATER SURFACE PROFILE INITIAL PLAN
- —— WATER SURFACE PROFILE FINAL PLAN
- o WATER SURFACE ELEVATIONS AT PERMANENT GAGES
- x WATER SURFACE ELEVATIONS AT TEMPORARY GAGES
- 7 PERMANENT MODEL GAGES CENTER OF CHANNEL
- 12&13 PERMANENT MODEL GAGES LEFT AND RIGHT EDGES OF CHANNEL RESPECTIVELY

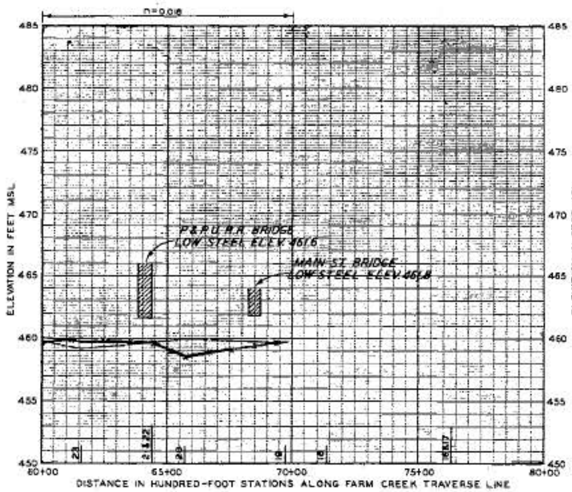
TEST CONDITIONS

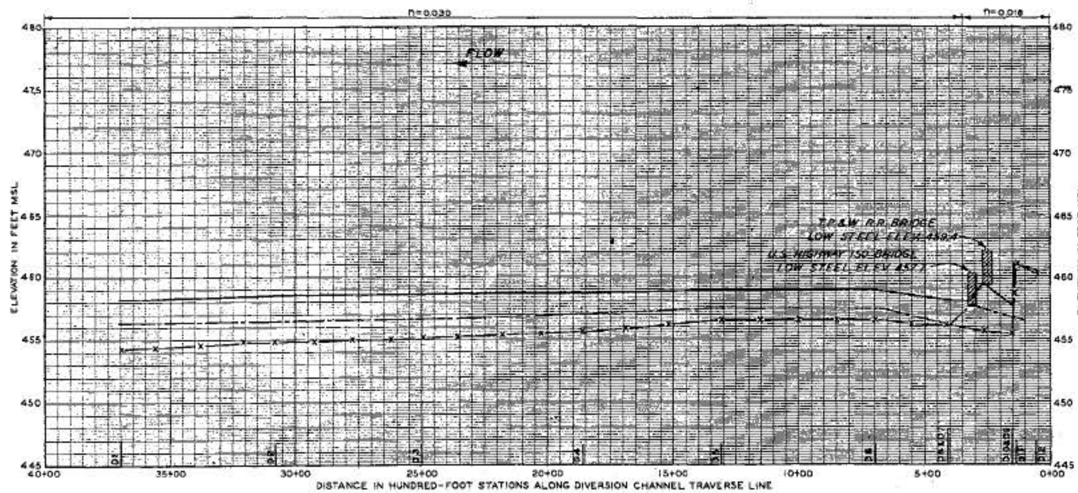
INFLOW		OUTFLOW ORIGINAL DESIGN		FINAL
FARM CREEK =	15,500 CFS	FARM CREEK =	14,000 CFS	9,500 CFS
KERFOOT CREEK =	3,900 CFS	DIVERSION CHANNEL =	8,000 CFS	12,500 CFS
COLE CREEK =	2,600 CFS			

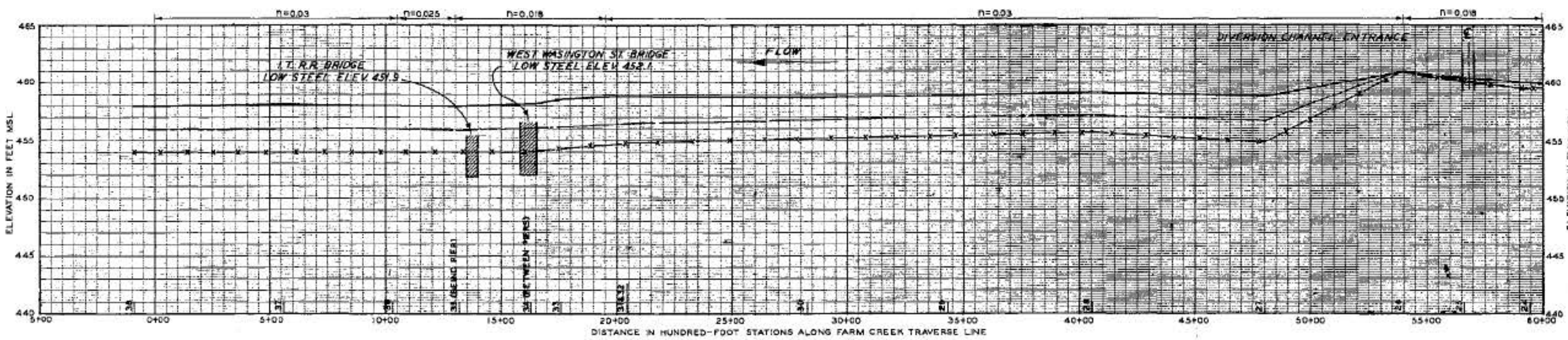
PROFILES ALONG CENTER LINE OF CHANNEL

FINAL PLAN

FARM CREEK







LEGEND

- WATER-SURFACE PROFILE 458 STAGE
- WATER-SURFACE PROFILE 456 STAGE
- WATER-SURFACE PROFILE 454 STAGE
- 37 PERMANENT MODEL GAGES CENTER OF CHANNEL
- 31&32 PERMANENT MODEL GAGES LEFT AND RIGHT EDGES OF CHANNEL RESPECTIVELY.

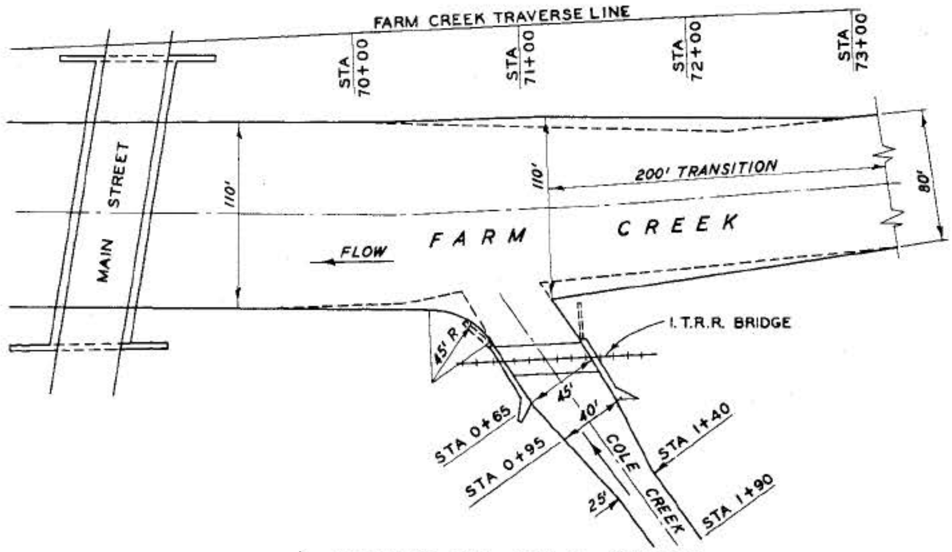
22,000 CFS FLOW CONDITIONS

458 STAGE - FARM CREEK 9,900 CFS - DIVERSION CHANNEL 12,100 CFS
456 STAGE - FARM CREEK 9,900 CFS - DIVERSION CHANNEL 12,100 CFS
454 STAGE - FARM CREEK 9,500 CFS - DIVERSION CHANNEL 12,500 CFS

PROFILES ALONG CENTER LINE OF CHANNEL

VARIOUS ILLINOIS RIVER STAGES

PLATE 7



MOUTH OF COLE CREEK

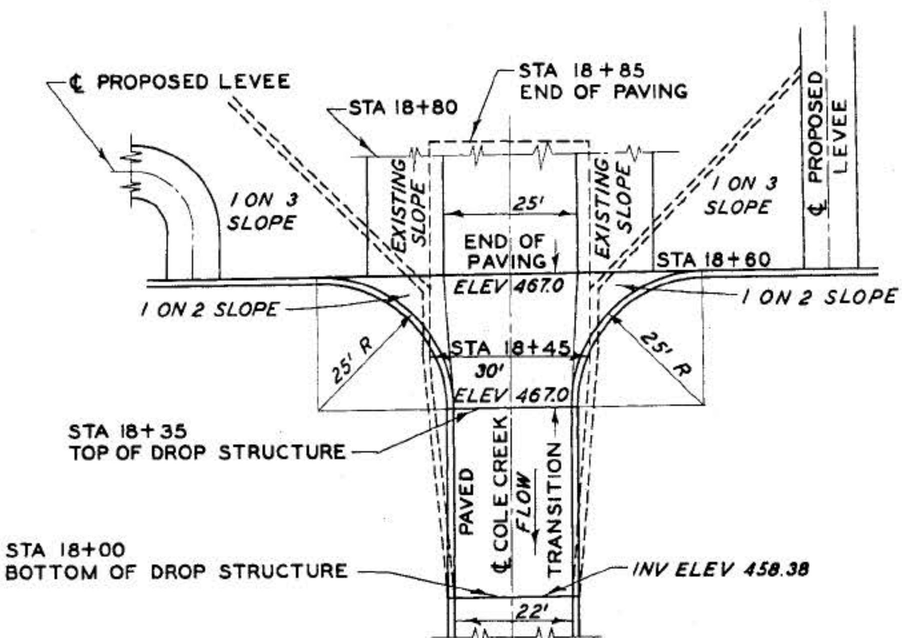
SCALE

50 0 50 100 FT

LEGEND

------ ORIGINAL DESIGN (BASE TEST)

——— FINAL DESIGN



DROP STRUCTURE–COLE CREEK

SCALE

20 0 20 40 FT

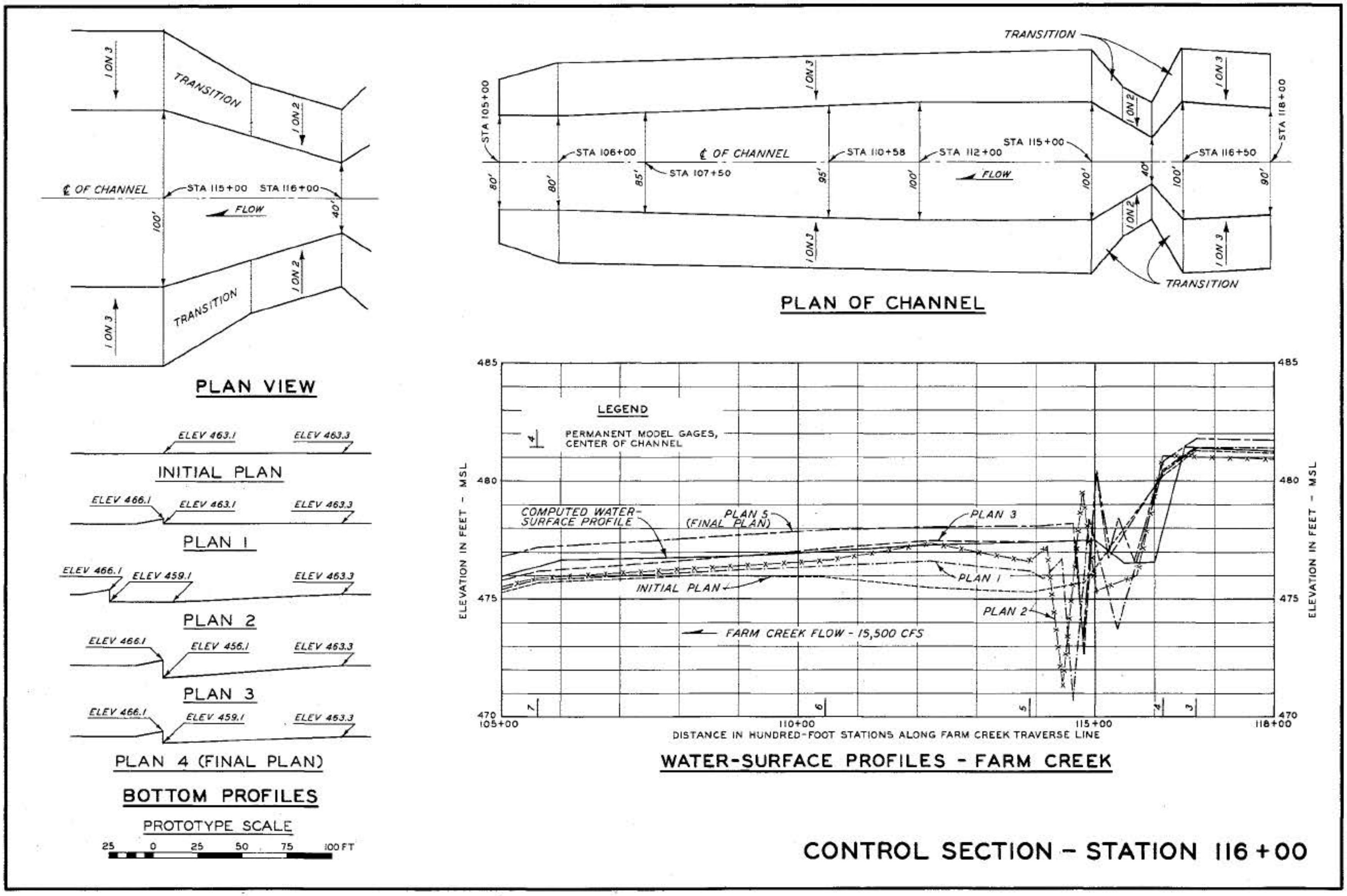
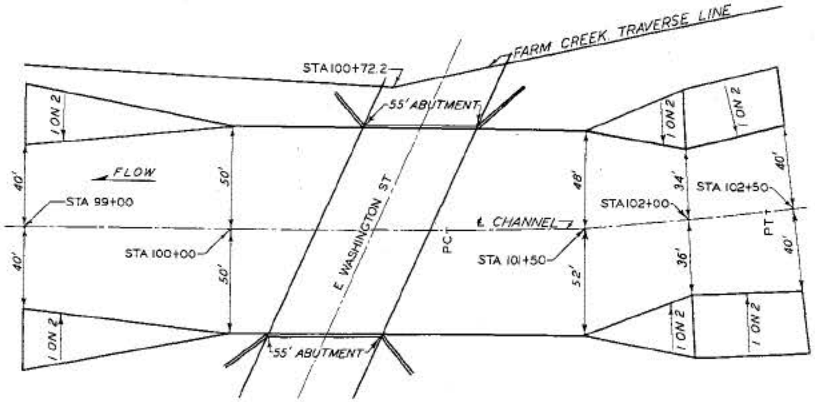
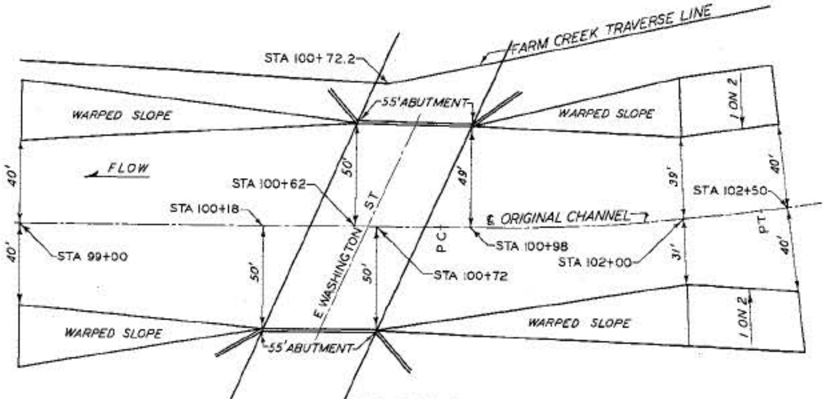

PLAN VIEW
¢ OF CHANNEL
STA 115+00
STA 116+00
FLOW
TRANSITION
1 ON 3
1 ON 2
100'
40'
INITIAL PLAN
PLAN 1
PLAN 2
PLAN 3
PLAN 4 (FINAL PLAN)
ELEV 466.1
ELEV 463.1
ELEV 463.3
ELEV 459.1
ELEV 456.1
BOTTOM PROFILES
PROTOTYPE SCALE
25 0 25 50 75 100 FT
PLAN OF CHANNEL
STA 105+00
STA 106+00
STA 107+50
STA 110+58
STA 112+00
STA 115+00
STA 116+50
STA 118+00
¢ OF CHANNEL
FLOW
TRANSITION
80'
85'
95'
100'
90'
WATER-SURFACE PROFILES - FARM CREEK
LEGEND
PERMANENT MODEL GAGES, CENTER OF CHANNEL
COMPUTED WATER-SURFACE PROFILE
PLAN 5 (FINAL PLAN)
PLAN 3
PLAN 1
PLAN 2
INITIAL PLAN
FARM CREEK FLOW - 15,500 CFS
ELEVATION IN FEET - MSL
485
480
475
470
105+00
110+00
115+00
118+00
DISTANCE IN HUNDRED-FOOT STATIONS ALONG FARM CREEK TRAVERSE LINE
CONTROL SECTION - STATION 116+00

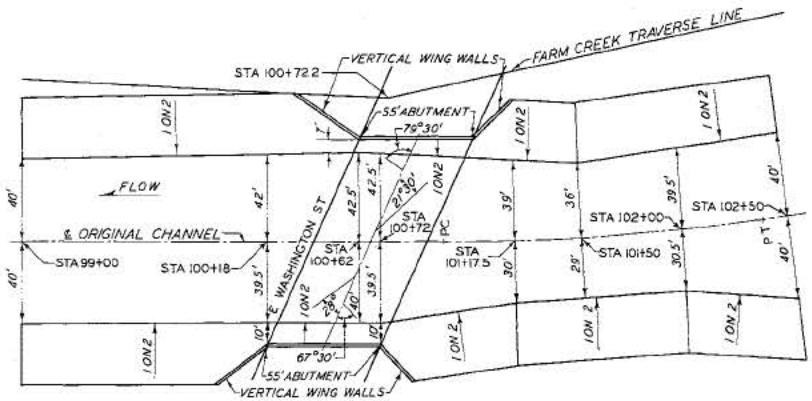
PLATE 9



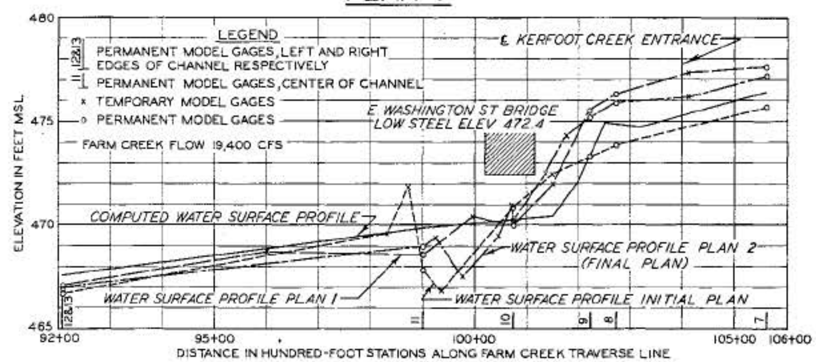
INITIAL PLAN



PLAN 1



PLAN 2
(FINAL PLAN)

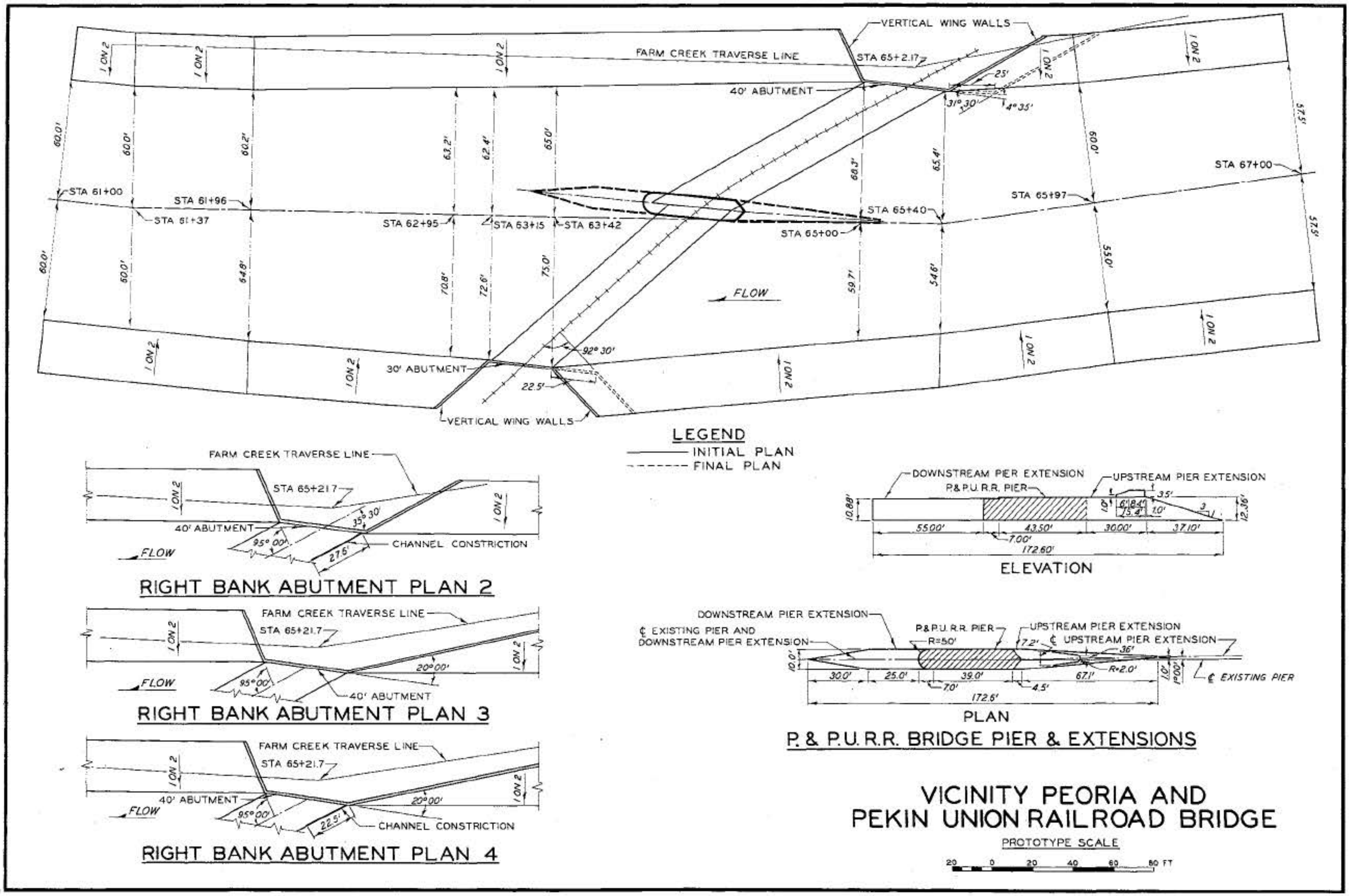


WATER SURFACE PROFILES
VICINITY E WASHINGTON ST BRIDGE

VICINITY EAST WASHINGTON STREET BRIDGE

PROTOTYPE SCALE

25 0 25 50 75 100 FT



VERTICAL WING WALLS
FARM CREEK TRAVERSE LINE
STA 65+2.17
40' ABUTMENT
30' ABUTMENT
STA 61+00
STA 61+96
STA 61+37
STA 62+95
STA 63+15
STA 63+42
STA 65+00
STA 65+40
STA 65+97
STA 67+00
FLOW
1 ON 2
LEGEND
INITIAL PLAN
FINAL PLAN
RIGHT BANK ABUTMENT PLAN 2
RIGHT BANK ABUTMENT PLAN 3
RIGHT BANK ABUTMENT PLAN 4
STA 65+21.7
CHANNEL CONSTRICTION
DOWNSTREAM PIER EXTENSION
UPSTREAM PIER EXTENSION
P.& P.U. R.R. PIER
ELEVATION
PLAN
¢ EXISTING PIER AND DOWNSTREAM PIER EXTENSION
¢ UPSTREAM PIER EXTENSION
¢ EXISTING PIER
P. & P.U. R.R. BRIDGE PIER & EXTENSIONS
VICINITY PEORIA AND
PEKIN UNION RAILROAD BRIDGE
PROTOTYPE SCALE
20 0 20 40 60 80 FT

PLATE 11

CORPS OF ENGINEERS, U. S. ARMY

CHANNEL IMPROVEMENTS, FARM CREEK, ILLINOIS

HYDRAULIC MODEL INVESTIGATION

TECHNICAL MEMORANDUM NO. 2-355

CONDUCTED FOR

CHICAGO DISTRICT, CORPS OF ENGINEERS

BY

WATERWAYS EXPERIMENT STATION

VICKSBURG, MISSISSIPPI

ARMY-MRC VICKSBURG MISS

FEBRUARY 1953

PREFACE

The study described herein was initiated by the District Engineer, Chicago District, CE, authorized by the Chief of Engineers, U. S. Army, and conducted by the Waterways Experiment Station.

An engineer of the Waterways Experiment Station inspected the prototype project and discussed the problem with representatives of the Chicago District before the model study was undertaken. Messrs. E. W. Nelson, R. Berk, and H. H. Schipper of the Great Lakes Division and Messrs. R. F. Leeper, R. T. Snider, and W. J. Santina of the Chicago District visited the Waterways Experiment Station at intervals during the course of the model study to program tests and to discuss test results. Reports describing progress of the study were submitted monthly to the District Engineer.

The model study was conducted by the Hydraulics Division of the Waterways Experiment Station during the period March 1949 to September 1950. Engineers actively connected with the study were Messrs. G. B. Fenwick, J. J. Franco, R. G. Cox, and C. D. McKellar.

CONTENTS

SUMMARY

Proposed channel improvements designed to prevent damage from flash floods in the lower reaches of Farm Creek, a tributary of the Illinois River, near the city of Peoria, Illinois, were tested in a fixed-bed model, built to an undistorted linear scale ratio of 1:60.

The results of the model investigation indicated that: (a) the proposed channel improvements will permit safe passage of the design flood; (b) minor changes in the improvement plans will greatly improve flow conditions; and (c) the capacity of a diversion channel can be increased sufficiently by enlargement of its cross section and redesign of its interceptive works to preclude the necessity of improvements in the main channel downstream.

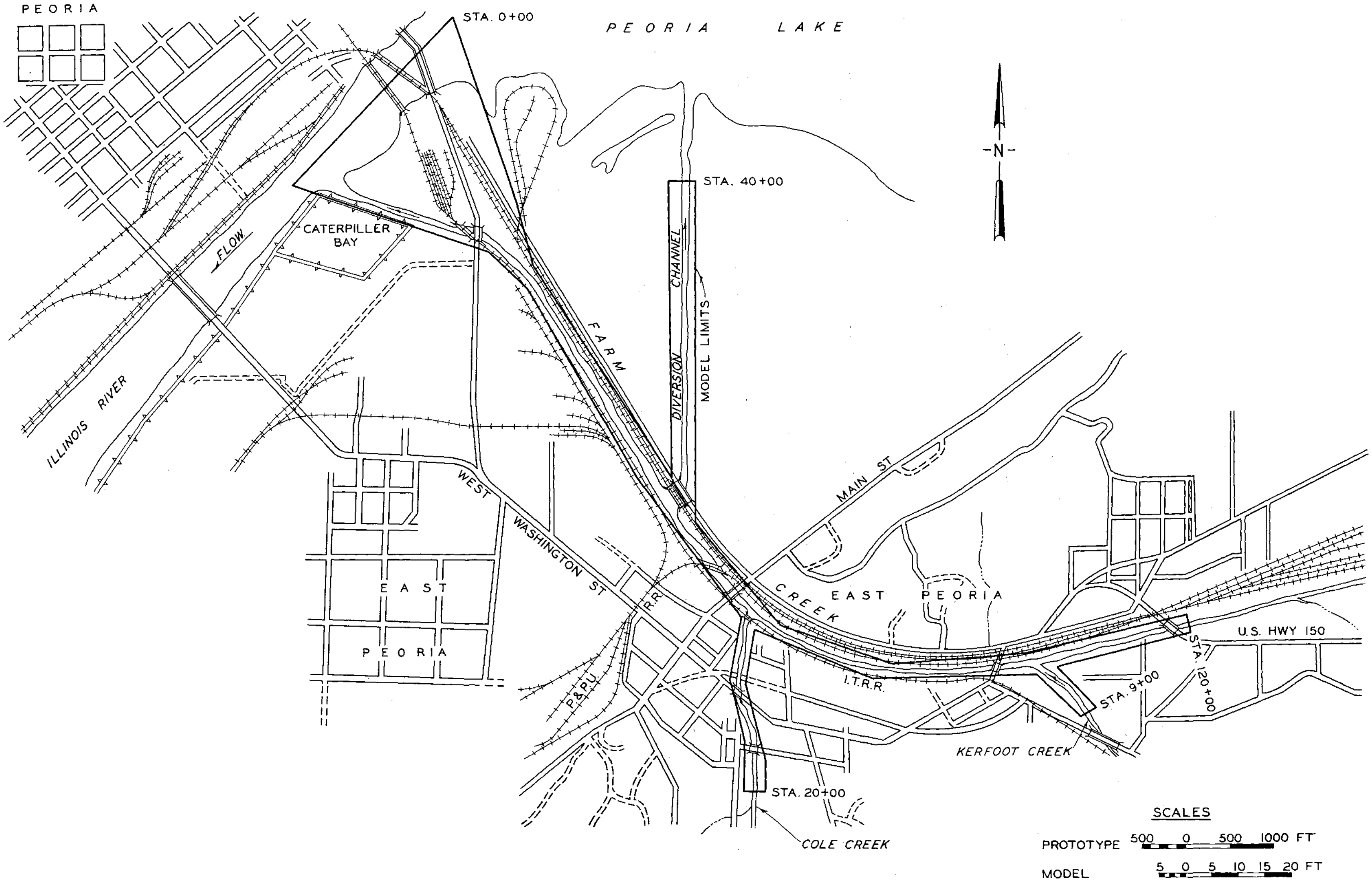


Fig. 1. Farm Creek Model limits; note highly industrialized location

CHANNEL IMPROVEMENTS, FARM CREEK, ILLINOIS

Model Investigations

PART I: INTRODUCTION

The Prototype

1. Farm Creek, a small stream having a total drainage area of 61.1 square miles, rises in eastern Tazewell County in central Illinois, and flows in a generally westerly direction for a distance of some 19 miles to its junction with the Illinois River near the city of Peoria (see figure 2). The upper reaches of Farm Creek and its tributaries are characterized by narrow floodplains and rolling hills predominantly undeveloped or devoted to agriculture. The lower reaches of the creek, where its wide floodplain merges into that of the Illinois River, are bordered by the highly industrialized city of East Peoria (figure 1). On either side of the floodplain are steep abutting hills. The topographical characteristics of the Farm Creek basin are conducive to flash floods of short duration and high rates of discharge. Damage in the upper basin from such floods is minor. However, some 1200 acres in the lower basin, consisting of residential and business districts as well as intensively industrialized sections, are subject to

Fig. 2. Vicinity map

potentially disastrous floods.

2. The creek has five principal tributaries, three of which (Dempsey, Kerfoot, and Cole Creeks) enter Farm Creek within the corporate limits of East Peoria. A man-made diversion channel flows in a northerly direction from the left bank of Farm Creek, in the heart of the industrialized area, to the Illinois River.

3. The flood hazard within the corporate limits of the city of East Peoria and vicinity results from the extremely limited channel capacity of lower Farm Creek and is greatly increased by confining railroad tracks and restricting bridge openings which entrap portions of the large debris load carried by the creeks during flood flows. This debris load further reduces channel capacities and increases flood heights.

The Definite Project Plan

4. Investigation of the flood problems in the Farm Creek basin was undertaken by the Corps of Engineers in 1939 and construction of the Farm Creek Flood Control Project was authorized by the Flood Control Act approved 22 December 1944, Public Law 534, 78th Congress. The protection plan provides for two upstream detention reservoirs controlling 52 per cent of the drainage area, levee construction and channel improvements in the vicinity of East Peoria, and modifications to the Farm Creek-Peoria Lake diversion channel.

The design flood

5. Examination of existing hydrological records on the problem basin and computations made thereon resulted in the selection of 22,000 cfs as the design flow for channel improvements in the lower reaches of

Farm Creek. The design flow is the maximum expected flood flow from the upper reach of Farm Creek, including minor outflows from the detention reservoirs, and 2,600-cfs and 3,900-cfs flows from Cole and Kerfoot Creeks, respectively. The maximum design flow derived for upper Farm Creek is 15,500 cfs, for Cole Creek 3,600 cfs, and for Kerfoot Creek 5,300 cfs. However, the timings of peak flows from Farm, Cole, and Kerfoot Creeks are such that the simultaneous combined discharge from the three streams is not expected to exceed 22,000 cfs.

The initially proposed
improvement plan

6. That part of the definite project plan that provides for improving flow conditions in Farm Creek and its tributaries within the city limits of East Peoria by enlarging and improving the existing channels includes the following specific items (see figure 3, following page).

7. Farm Creek. The bankfull capacity of Farm Creek channel is to be increased from 16,000 cfs to 22,000 cfs by the following measures:

a. The channel to have a slope of 0.002 within the improved area from sta 0+00 to sta 211+20. The existing stable general slope is 0.0025.

b. The channel to be deepened and widened between sta 0+00 and sta 121+44, portions thereof paved where velocities will exceed 8.5 ft per sec, and control structures provided at sta 17+50, 100+72 and 116+00.

c. Existing levees to be improved and new levees to be constructed to provide a 2-ft freeboard throughout the improved area.

d. Alignment of channel to be altered between sta 169+90 and sta 211+20 to provide better bank protection in the vicinity of the Toledo, Peoria and Western Railroad bridge located at sta 190+08; channel alignment to include pilot channels having bottom widths of 20 ft from sta 178+96 to sta 190+08, and 100 ft from sta 190+08 to sta 211+20.

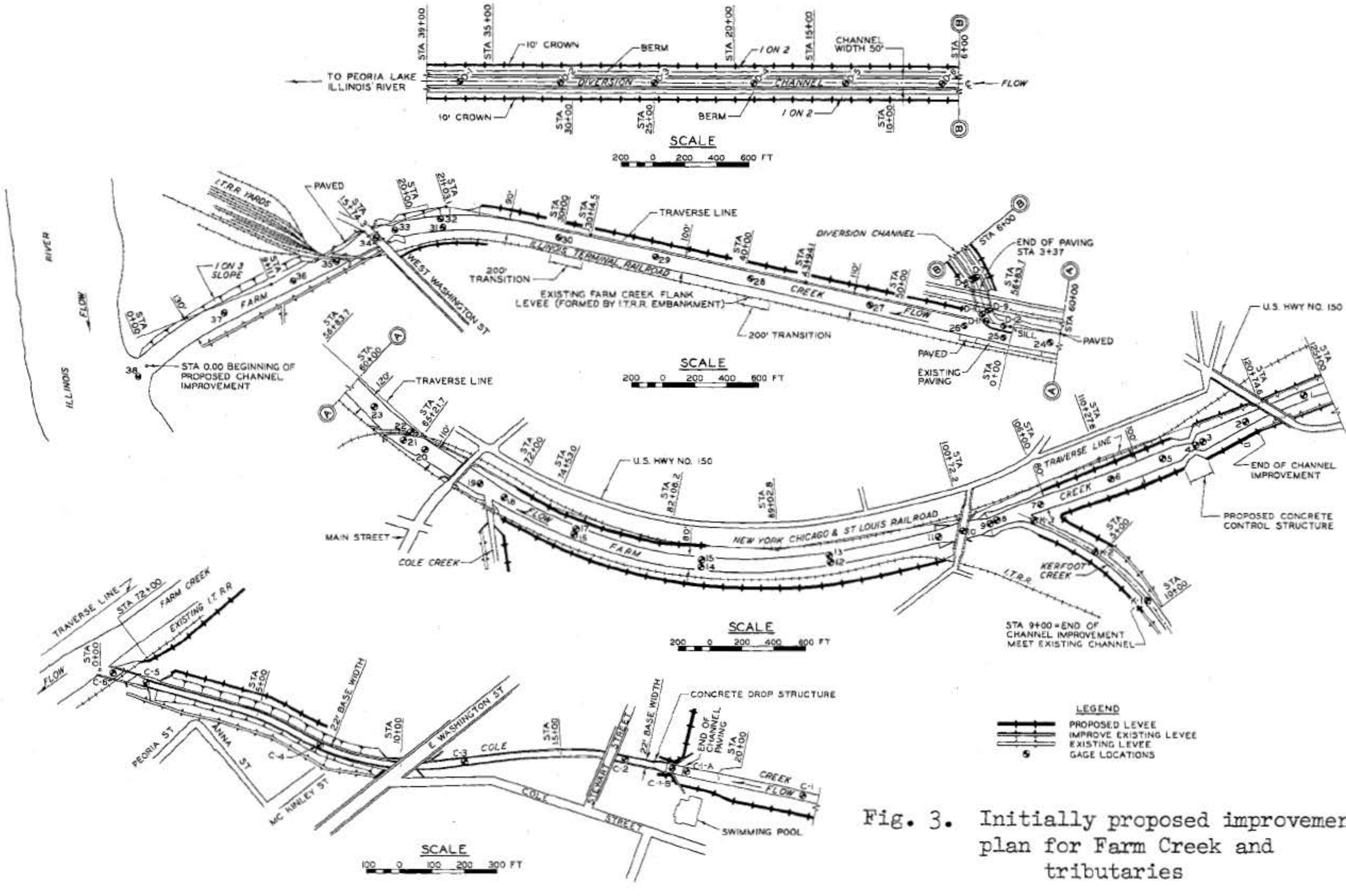


Fig. 3. Initially proposed improvement plan for Farm Creek and tributaries

In general, the definite project plan provides for paving the channel where erosion might result from velocities exceeding 8.5 ft per sec, and for control structures designed to reduce velocities and thereby avoid extensive channel paving. Computed design velocities between sta 0+00 and sta 11+00 exceed 8.5 ft per sec, but no erosion protection is to be provided in this reach because levee failure would not cause serious damage between sta 0+00 and sta 8+00, and because the left bank between sta 9+00 and sta 11+00 is adequately protected by riprap where levee failure would result in extensive damage.

8. Diversion channel. The bankfull capacity of the Farm Creek-Peoria Lake diversion channel is to be increased from 6,000 to 8,000 cfs by the following improvements (figure 3):

a. Installation of an interceptor at sta 0+00.

b. Enlargement of the channel section and construction of levees to provide a 2-ft freeboard between sta 3+37 and Peoria Lake.

9. Cole Creek. The bankfull capacity of Cole Creek to be increased from 2,000 cfs to 3,600 cfs by the following improvements (figure 3):

a. Realignment and paving of the channel from sta 0+00 to sta 1+90 to improve hydraulic conditions at its confluence with Farm Creek.

b. Realignment, enlargement, and paving of the channel from sta 1+90 to sta 18+00 to provide a 22-ft-wide rectangular section.

c. Installation of a drop structure at sta 18+35.

d. Replacement of two existing two-span highway bridges with clear-span bridges and relocation of the Illinois Terminal Railroad bridge.

e. Construction of required levees to provide a 2-ft freeboard between sta 0+00 and 18+50.

10. Kerfoot Creek. The bankfull capacity of the lower reach of Kerfoot Creek is to be increased from 4,800 cfs to 5,300 cfs by the following improvements:

- a. Realignment and paving of the channel from sta 0+00 to sta 1+20 to improve hydraulic conditions at its confluence with Farm Creek.
- b. Realignment and enlargement of the channel from sta 1+20 to sta 9+00 to improve channel conditions.
- c. Construction of required levees to provide a 2-ft freeboard between sta 0+00 and 9+00.

Need for and Purpose of Model Study

11. The improvements proposed for Farm Creek and its diversion channel and tributaries include numerous structures involving hydraulic problems that could not be conclusively solved by computations. These problems consisted mainly of determining losses resulting from control structures, bridge piers, variable channel sections, stream confluences, and an interceptor wall. The Farm Creek model was designed and built to test the hydraulic performance of these proposed structures and to correct any unsafe or undesirable conditions resulting from their installation. In addition, the computed capacities of the various channels were to be checked and the combinations of discharges, if any, that would produce undesirable effects at the locations of hydraulic jumps, thereby affecting the structural design assumptions for uplift or bank protection, were to be determined.

PART II: THE MODEL AND THE TESTING PROGRAM

Description of Model

12. The Farm Creek model (figure 4) was a scale reproduction of a small section of the Illinois River, of Farm Creek from its mouth to

Fig. 4. The Farm Creek model

sta 120+00, of the diversion channel from its origin at Farm Creek to sta 40+00, of Kerfoot Creek from its confluence with Farm Creek to sta 9+00, and of Cole Creek from its confluence with Farm Creek to sta 20+00.

13. The model was of the fixed-bed type with all channel and overbank areas molded in cement mortar to female templets. The required model roughness was obtained by varying the texture of the mortar finish.

Channel areas to be paved in the prototype were reproduced in the model by a trowel-finished surface, unpaved areas by a thin stucco veneer, and riprapped areas by brush-finished concrete (figure 5). All model bridge

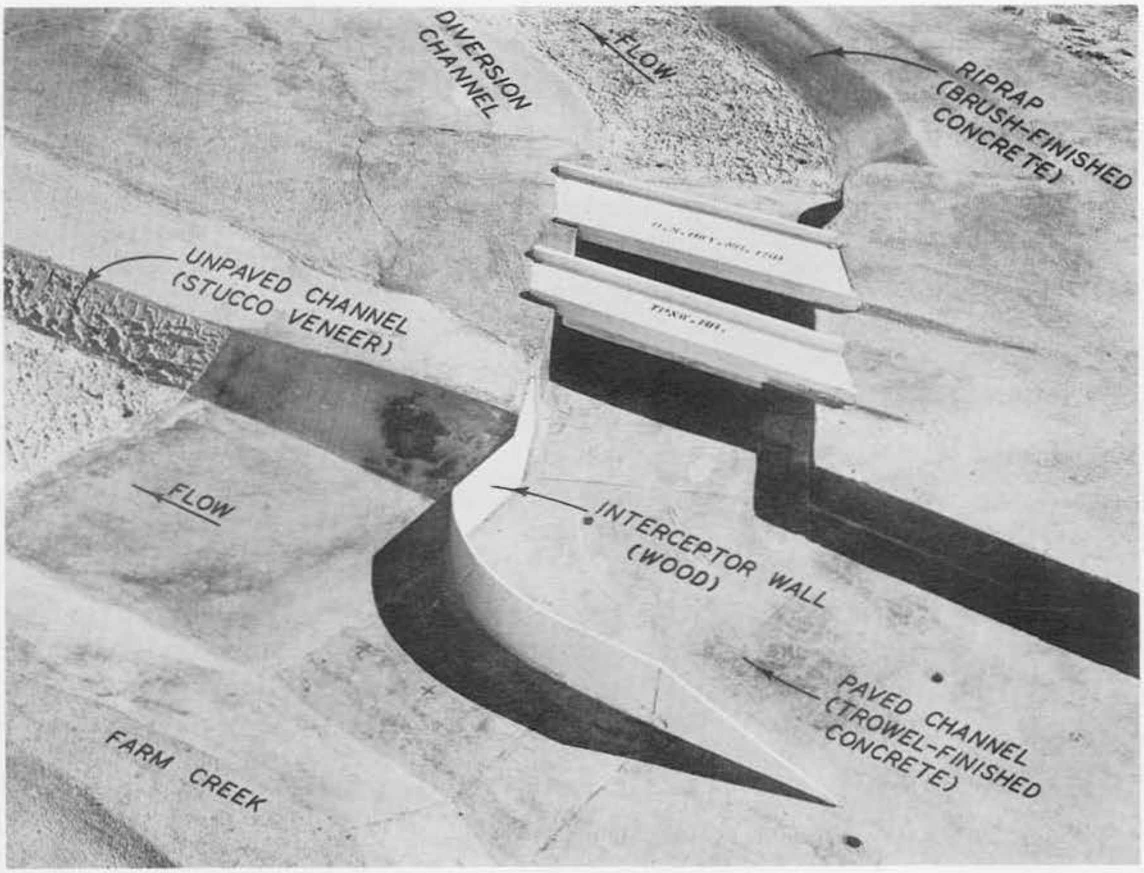


Fig. 5. Types of roughness used in the model

piers, end sills, and interceptors were fabricated from wood.

14. The model was built to an undistorted scale of 1:60, model to prototype, to effect accurate reproduction of hydraulic conditions at drop and control structures and of the water surfaces at obstructions and changing sections. Other scale ratios, computed directly from the linear scale ratio, were: area, 1:3600; volume, 1:216,000; discharge, 1:27,900; velocity and time, 1:7.74.

Appurtenances and Their Applications

15. Water used in operation of the model was supplied by a circulating system with discharges measured by a venturi meter and Van Leer and V-notch weirs. Flows were introduced into upper reaches of Farm Creek through the venturi meter and into the upper reaches of Kerfoot and Cole Creeks by means of Van Leer weirs. Outflows from the model at the confluence of Farm Creek and the Illinois River and at the end of the diversion channel were measured by means of V-notch weirs. Adjustable tailgates controlled water-surface elevations in the lower reaches of the model.

16. Water-surface elevations throughout the model were measured by means of 61 piezometer-type gages located in the four channels reproduced in the model (table 1 and figure 3). A portable point gage was used to obtain water-surface elevations at critical locations not covered by the permanent gage installations.

17. Velocities were measured with a Bentzel tube.

Testing Program

18. The study was divided into three distinct testing phases: (a) adjustment of the model to insure accurate reproduction to model scale of the Manning's "n" values used in computations on which the design of proposed channel improvements was based; (b) testing of the design plan; and (c) testing of modifications to the design plan.

Model Adjustment

19. Inclusion of the proposed Farm Creek channel improvements in

the initial model construction precluded adjustment of the model to known prototype data. Therefore, it was necessary to insure that the model roughness values were comparable to those existing in the prototype unimproved channel sections and to those used in theoretical computations on which the design of channel improvements was based. Roughness values used in the prototype design were 0.025 for riprapped surfaces, 0.030 for earth sections, and 0.018 for paved sections of the channels. Corresponding model roughness values were 0.0126, 0.0152, and 0.0091, respectively. A series of tests was undertaken in a special test reach of the model to determine the texture required on the model surfaces to simulate the design prototype roughness values. Upon conclusion of these tests, the various channel sections of the model were coated with the degree of roughness indicated by the test results. A test was then undertaken to determine the ability of the model to reproduce the computed water-surface profiles of the initial plan of improvement. Model and computed water-surface profiles were in close agreement through reaches of uniform channel sections thus indicating that proper roughness values prevailed in the model (plates 1 and 2).

PART III: NARRATIVE OF TESTS

Test Procedure

20. All tests were conducted with constant stages established in the model. The desired inflows were set, water-surface elevations in the lower reaches of the model adjusted by operation of the tailgates, and the model permitted to stabilize prior to obtaining test data. Data obtained consisted of inflow and outflow measurements, water-surface elevations and velocity measurements, visual observations, and photographic records of flow conditions. Velocity measurements were obtained at mid-depths.

Test of Initial Improvement Plan

21. The purposes of testing the initial improvement plan were to check the hydraulic phenomena expected to result from this plan, and to establish a base or standard for comparison with results of subsequent tests of modifications of the initial improvement plan.

22. All elements of the initial improvement plan located within the model limits (paragraphs 6-10 and figure 3) were installed in the model and tested for the following inflows and outflows:

Inflow cfs	Outflow cfs
Farm Creek, 15,500	Farm Creek, 14,000
Kerfoot Creek, 3,900	Diversion channel, 8,000
Cole Creek, 2,600	

It was noted at the beginning of the tests that the diversion channel was discharging 7,500 cfs rather than the design flow of 8,000 cfs.

Therefore, Farm Creek below the diversion channel entrance was constricted to force an additional 500 cfs into the diversion channel, thus permitting direct comparison of model data with computed design data.

23. Water-surface elevations obtained along the center lines of the channels were in close agreement with computed elevations except in the vicinity of drop structures, control structures, channel obstructions, variable channel sections, and stream confluences (table 2, plates 1 and 2).

24. Velocities in the model areas representing unpaved prototype areas generally exceeded the 8.5-ft-per-sec design velocities. Velocities ranged from 7.4 ft per sec to 14.0 ft per sec in the unpaved areas of Farm Creek, from 6.4 to 9.5 ft per sec in the diversion channel, as high as 11.4 ft per sec in Cole Creek, and from 4.3 to 6.7 ft per sec in Kerfoot Creek (table 3).

25. The following undesirable local flow conditions were noted:

- a. Superelevation of the water surface along the left bank at the entrance to the diversion canal resulted in submergence of the sub-structure of the highway bridge across the canal.
- b. Standing waves created by the Peoria and Pekin Union Railroad bridge pier and abutments at sta 62+21 on Farm Creek caused partial submergence of the bridge sub-structure.
- c. The drop structure on Cole Creek at sta 18+35 created standing waves which were amplified by downstream bends in the creek.
- d. The protuberance in the left bank of Farm Creek just below the mouth of Cole Creek resulted in considerable disturbance in Farm Creek and backwater in Cole Creek.
- e. Flow leaving the Farm Creek control structure at sta 116+00 was directed along the left bank of the unpaved area between the control section and the mouth of Kerfoot Creek (sta 106+00).

f. Channel alignment in the vicinity of the East Washington Street bridge at Farm Creek sta 100+68 caused a standing wave below the bridge and partial submergence of the bridge sub-structure by secondary waves upstream.

26. One purpose of the model investigation was to test the hydraulic performance of the various structures involved in the channel improvement plan and to correct any unsafe or undesirable conditions resulting from installation of these structures. Tests of the initial improvement plan indicated that considerable local improvements in flow conditions were desirable. Therefore, several tests of modified improvement plans were undertaken in the various problem areas simultaneously in order to expedite the study. However, each problem area was in effect an independent study, and is so treated in this report.

Tests of Diversion Channel and Entrance

27. Tests of the diversion channel were first undertaken to improve flow conditions at the channel entrance. However, it was soon apparent that if the diversion channel could be made to carry 12,500 cfs during the design flood of 22,000 cfs, improvements in the lower Farm Creek channel would not be necessary. Therefore, subsequent tests were directed toward interception of 12,500 cfs rather than the originally planned 8,000 cfs. The design flow of 22,000 cfs was used in all tests of the diversion channel.

Plan 1

28. The first modified plan tested to increase the efficiency of the diversion channel consisted of realigning the right bank of Farm Creek upstream from the Toledo, Peoria, and Western Railroad bridge

(plate 3). This revision resulted in an increase in the cross-sectional area between the right bank and the interceptor wall.

29. Realignment of the right bank of Farm Creek resulted in a natural diversion channel flow of 8,100 cfs. Standing waves created by the entrance channel configuration submerged portions of the sub-structure of the highway bridge immediately downstream. Water-surface elevations in the diversion channel were generally increased over those resulting in the test of the initial plan (table 4).

Plan 2

30. The second modified plan tested consisted of decreasing the length of the interceptor wall 115 ft from sta 0+00 to sta 1+15 and relocating the diversion sill at sta 1+15 (plate 3). Also, the right bank revision of plan 1 was retained.

31. The plan 2 revisions resulted in a natural diversion channel flow of 9,200 cfs accompanied by velocity and stage increases (tables 4 and 5). The stage increases resulted in greater submergence of the highway bridge than for plan 1 conditions.

Plan 3

32. The third modified plan (plate 3) consisted of further realignment of the right bank of Farm Creek to include a vertical wall extending 190 ft upstream from the diversion channel; realigning and increasing the length of the interceptor wall to sta 1+00; elimination of the diversion sill; installation of three 5-ft-high splitter walls in the diversion channel entrance; redesign of the diversion channel transitions downstream from the highway bridge, and enlargement and redesign of the diversion channel to provide a bottom width of 100 ft, 1-on-3 side slopes,

and a roughness value of 0.030 (prototype).

33. Tests with the enlarged diversion channel resulted in a diversion of 12,200 cfs from Farm Creek. An unstable hydraulic jump formed on the downstream side of the highway bridge, intermittently submerging the sub-structure of the bridge. Tables 4 and 5 show water-surface elevations and velocities obtained with the enlarged diversion channel.

34. Installation of three 5-ft-high splitter walls had no appreciable effect upon capacity of or flow conditions in the entrance channel.

Plan 4 (final design)

35. The results of tests of plan 3 indicated that the diversion channel could be made to carry 12,500 cfs of the design flow of 22,000 cfs, leaving 9,500 cfs to pass through the lower Farm Creek channel. Examination of discharge records and computations made thereon indicated that the lower Farm Creek channel in its present unimproved condition was capable of carrying 9,500 cfs with the required freeboard of 2 ft. Therefore, a series of preliminary tests was made with flows of 9,500 cfs in lower Farm Creek and 12,500 cfs produced in the diversion channel by arbitrarily constricting the lower Farm Creek channel. Under these conditions a water-surface elevation of 460.1* was obtained at sta 55+75 and flow conditions upstream were not adversely affected. The unimproved reach of Farm Creek immediately below the diversion channel, which constitutes a natural control as a result of side and bottom contraction, was then remolded. The improved channel below this control section was not remolded as it had no effect upon flow conditions upstream. Elements of plan 4 were then

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* All elevations used in this report are referenced to mean sea level.

installed in the model.

36. The fourth and final plan (plate 3 and figure 6) retained the following elements of plan 3: (a) realignment of the right bank of Farm Creek, (b) the enlarged diversion channel with roughness factor of 0.030, (c) the redesigned diversion channel transition walls downstream from the highway bridge, and (d) the redesigned interceptor wall. In addition, plan 4 included a 1-on-3 sloping extension to the interceptor wall, a redesigned transition in Farm Creek below the interceptor wall to effect a return to the original channel section, and a deflector wall in the

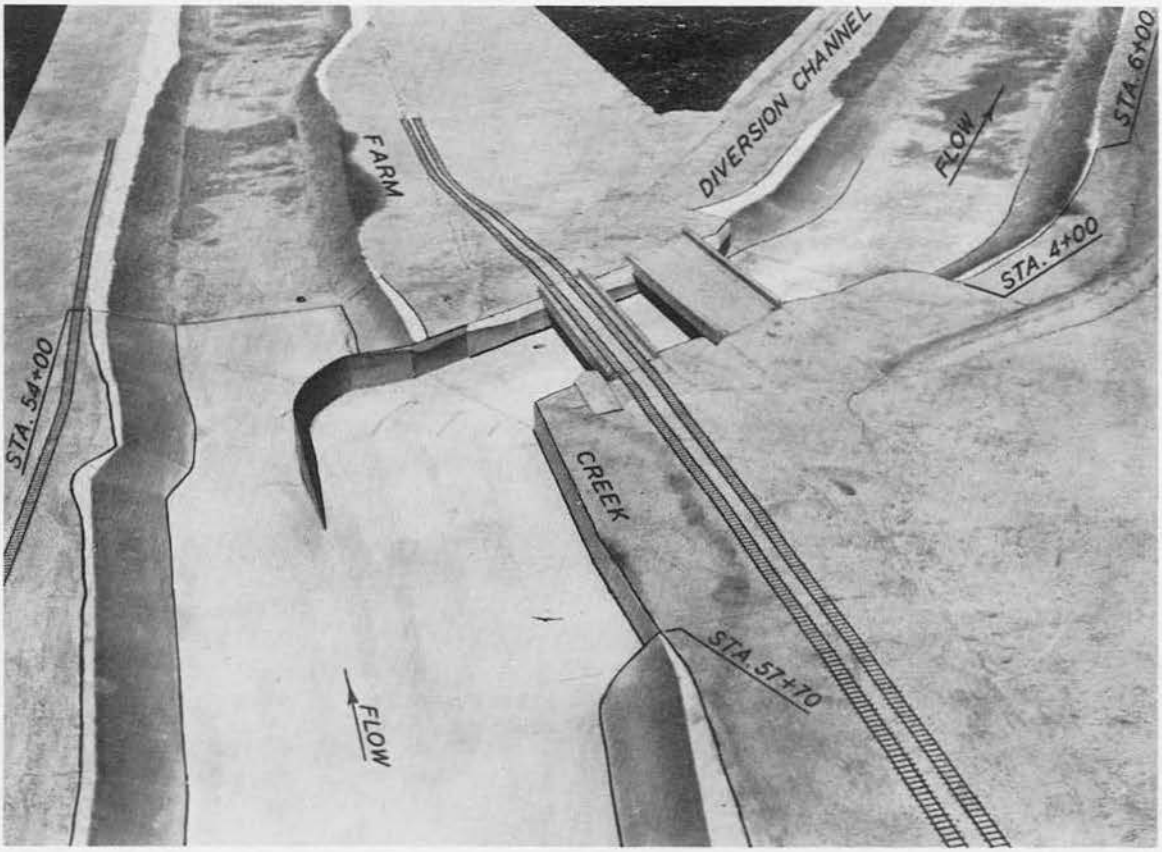


Fig. 6. Elements of the final plan, diversion channel entrance

diversion channel entrance to induce a downstream movement of the hydraulic jump resulting with plan 3 test conditions.

37. All primary tests of plan 4 were conducted with flows of 22,000 cfs and with water-surface elevations in the exit channels controlled by the configurations and roughnesses. Secondary tests were conducted to determine the division of flow and water-surface elevations for discharges other than the design flow of 22,000 cfs, and to determine the effects of high Illinois River stages on flow conditions in Farm Creek and in the diversion channel.

38. Installation of plan 4 in the model resulted in a natural flow of 12,500 cfs through the diversion channel with the remaining 9,500 cfs of the 22,000 cfs design flow carried by lower Farm Creek. Plate 4 is a graph showing the division of flows between Farm Creek and the diversion channel for various total flows. Water-surface elevations in the diversion channel and in Farm Creek above the diversion channel for the design flow with a low Illinois River stage are tabulated on table 4. Water-surface elevations in the lower Farm Creek channel are not tabulated as the improved channel of this reach was not installed in the model. The water-surface profile in the diversion channel for a flow of 12,500 cfs is shown on plate 5. A comparable profile for a flow of 9,500 cfs in Farm Creek immediately below the diversion channel is shown on plate 6.

39. Velocities in the diversion channel for a flow of 12,500 cfs ranged from 13.9 ft per sec at sta 3+37 to 7.0 ft per sec at sta 36+15 (table 5). Velocities in the upper reach of the diversion were increased 30 to 40 per cent over those of the test of the initial improvement plan, while those in the lower reach were decreased about 30 per cent. The maximum velocity of 13.9 ft per sec was in the paved channel under the highway bridge.

Fig. 7. Flow conditions in final plan diversion channel entrance without (above) and with deflector wall. Discharge in diversion channel, 12,500 cfs

40. Flow conditions under the highway bridge spanning the diversion channel without the deflector wall installed (plate 3, plan 4) were similar to those noted for plan 3 conditions. A hydraulic jump formed at the downstream end of the bridge intermittently submerging the sub-structure of the bridge. Installation of the deflector wall caused the jump to form downstream from the bridge. Figure 7 shows flow conditions without and with the deflector wall.

41. The results of tests (plate 7) made to determine the effects of high Illinois River stages on flow conditions in Farm Creek and the diversion channel show that Illinois River stages between 448 and 458 ft generally raised stages in the diversion channel. A stage of 456 ft submerged the sub-structure of both the highway bridge and the railroad bridge. The submergence of the sub-structures of the bridges across the diversion channel as a result of high Illinois River stages was accompanied by a 400-cfs reduction in channel capacity (12,500 cfs to 12,100 cfs) with a comparable increase in flow in Farm Creek (9,500 cfs to 9,900 cfs).

Cole Creek Tests

42. Details of improvement plans to increase the capacity of Cole Creek from 2,000 cfs to 3,600 cfs are discussed in paragraph 9 and shown on plate 8. Results of the test of the initial improvement plan (2,600-cfs Cole Creek flow) indicated certain adverse flow conditions. These adverse conditions consisted of standing waves generated by the drop structure located at sta 18+35 and amplified by the bends downstream so that they continued until merged with unstable flow below the confluence of Cole and Farm Creeks. The unstable flow below the mouth of Cole

Creek resulted from malalignment of the confluence which in turn caused large waves at and upstream from the Main Street bridge and backwater in Cole Creek (paragraph 25d). Redesign of the drop structure and realignment of the stream confluence were undertaken to effect improvements in these conditions.

43. Redesign of the drop structure at sta 18+35 comprised replacement of the angular training walls by curved training walls having radii of 25 ft, and extension of the rectangular 22-ft-wide channel section upstream to the top of the structure. The natural channel above the structure was reshaped to have 1-on-3 side slopes (plate 8 and figure 8). The protuberance at the confluence was removed and Farm Creek widened to effect a uniform transition from 80 ft to 110 ft in the vicinity of Cole Creek (plate 8 and figure 9).

44. The redesigned drop structure eliminated the standing waves between the drop structure and sta 16+00 and reduced velocities about 50 per cent in the unpaved section upstream from the drop structure. However, standing waves began to form in the first bend downstream at sta 16+00, increased in size in the bend at sta 11+00 and continued downstream until they were damped by backwater from Farm Creek.

45. Channel realignment at the confluence of Farm and Cole Creeks eliminated the large waves at and upstream from the Main Street bridge with a resulting reduction in water-surface elevations at the bridge (sta 68+50) of about two feet (table 2 and plate 6).

46. The above improvements in Cole Creek were investigated with the Farm Creek design flood, which provides for a flow of only 2,600 cfs in Cole Creek. Since the Cole Creek design flow is 1,000 cfs higher,

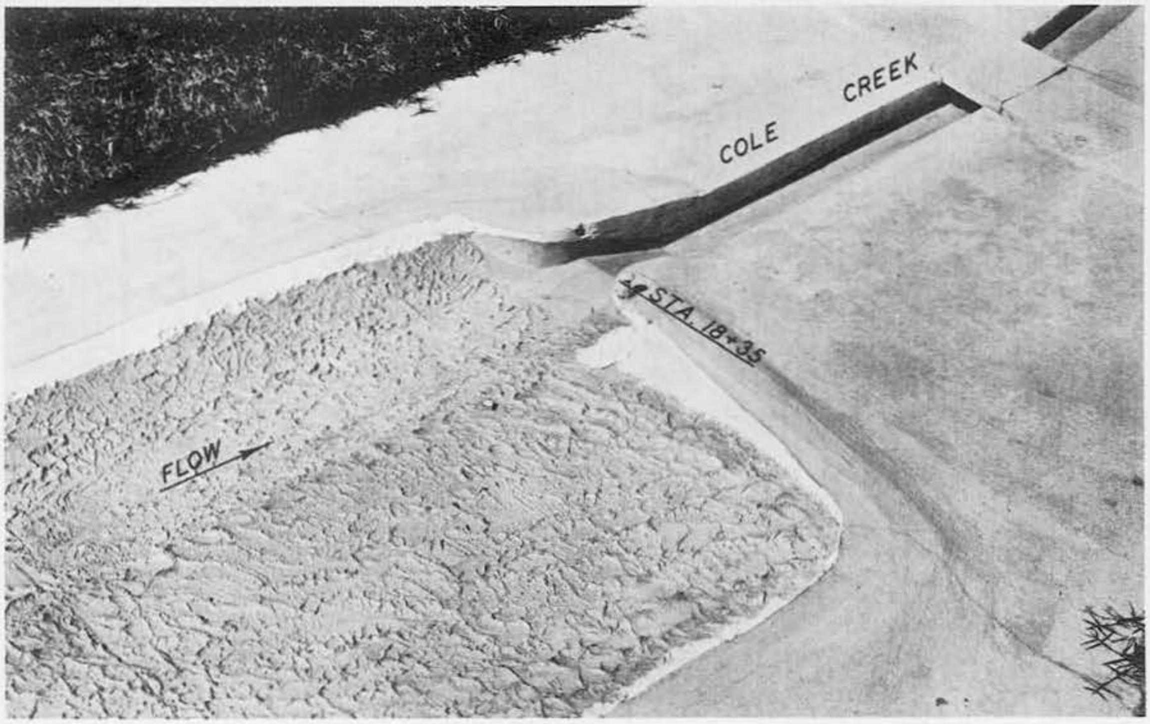


Fig. 8. Final plan for Cole Creek drop structure

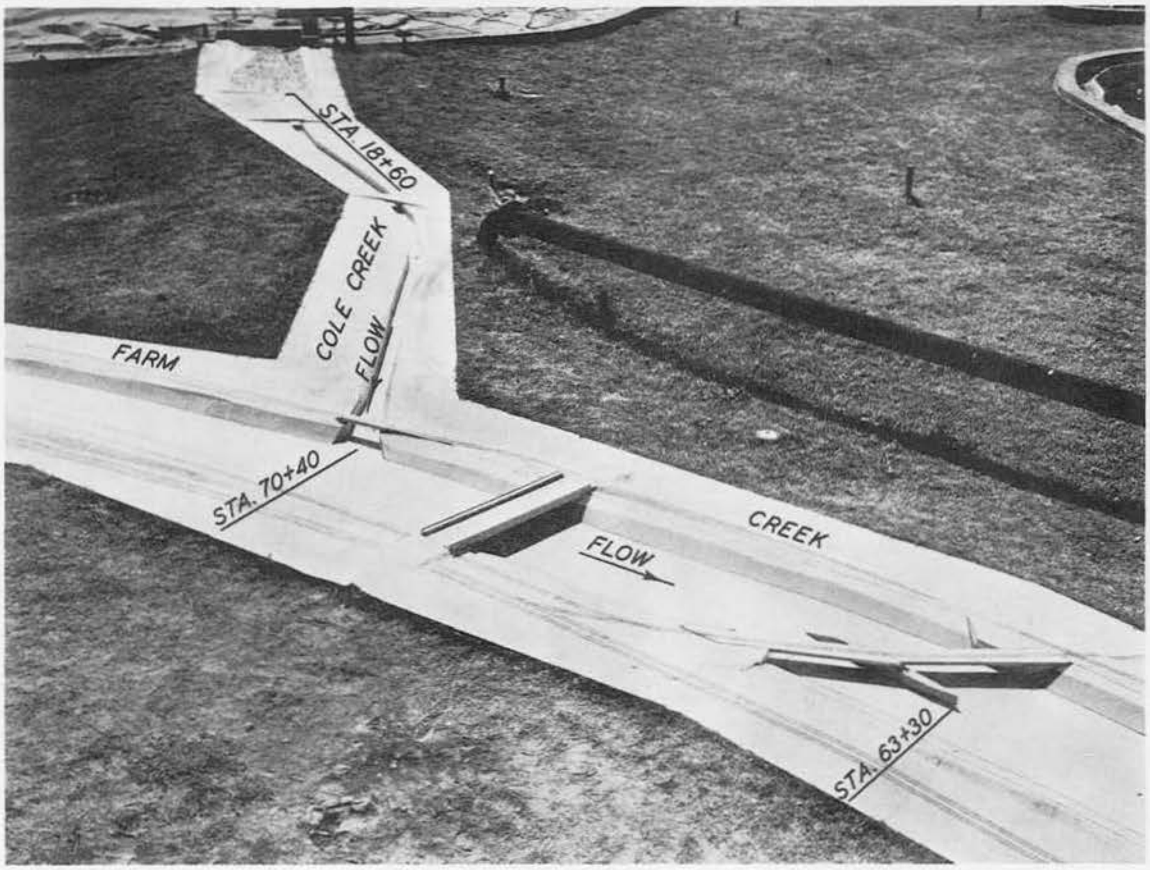


Fig. 9. Center reach of Farm Creek; note uniform transition in vicinity of Cole Creek

the improvements therein were also tested with a Cole Creek flow of 3,600 cfs. Farm Creek and Kerfoot Creek flows for this test were 9,800 cfs and 5,300 cfs, respectively. Water-surface elevations observed in Cole Creek for this combination of flows are shown in comparison with proposed retaining wall elevations in table 6. Examination of this table will show the need for increasing the wall height between sta 0+00 and sta 2+00 to provide the desired 2-ft freeboard.

Farm Creek Control Structure Tests (Sta 116+00)

47. The Farm Creek control structure (figure 10) at sta 116+00 as originally designed resulted in concentration of flow along the unpaved left bank between sta 106+00 and 115+00 (paragraph 25e). Four modified control structure plans were tested in the model to improve flow

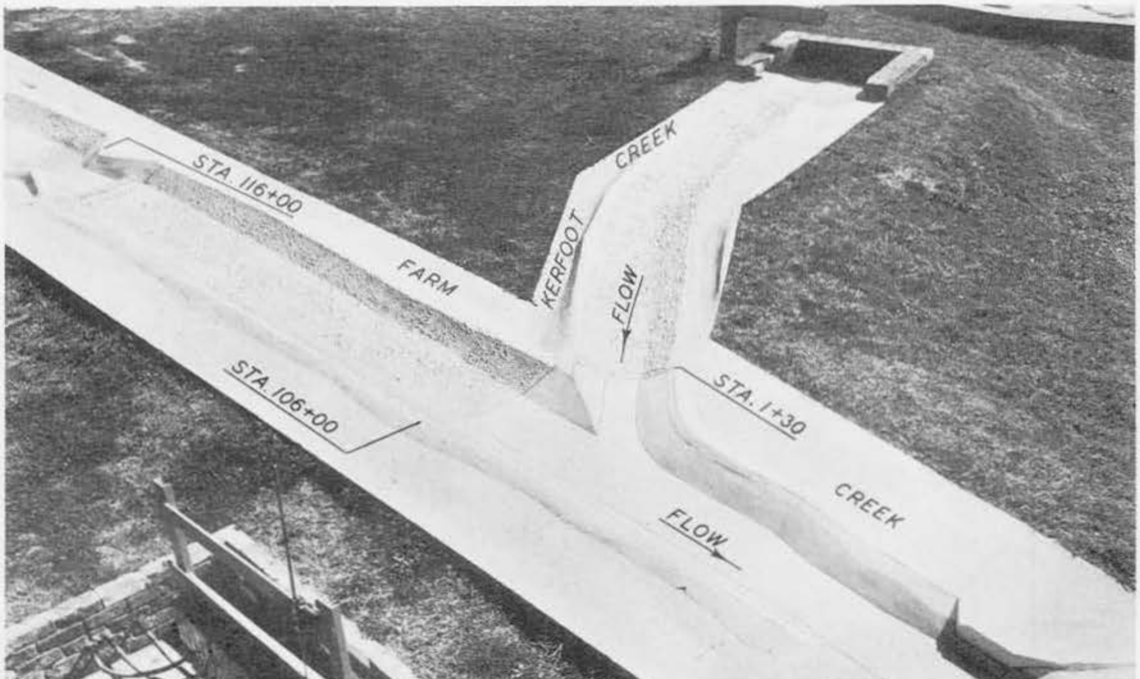


Fig. 10. Upper reach of Farm Creek

distribution in this area.

48. Modifications to the control structure were made to determine the optimum height and location of the end sill (plate 9). No changes were made upstream from the control section. All tested modifications retained an end sill elevation of 466.1 ft with heights of end sills varying from 3 to 10 ft. The end sill was located at sta 115+00 except in tests of plan 2 in which it was located at sta 114+70. A Farm Creek discharge of 15,500 cfs was used for testing end sill requirements.

49. Test results showed that the 7-ft end sill (plan 4) produced optimum flow conditions, generally reduced velocities in the unpaved section downstream, and eliminated the concentration of flow along the left bank between sta 106+00 and 115+00 (plate 9, tables 7 and 8, and figure 11).

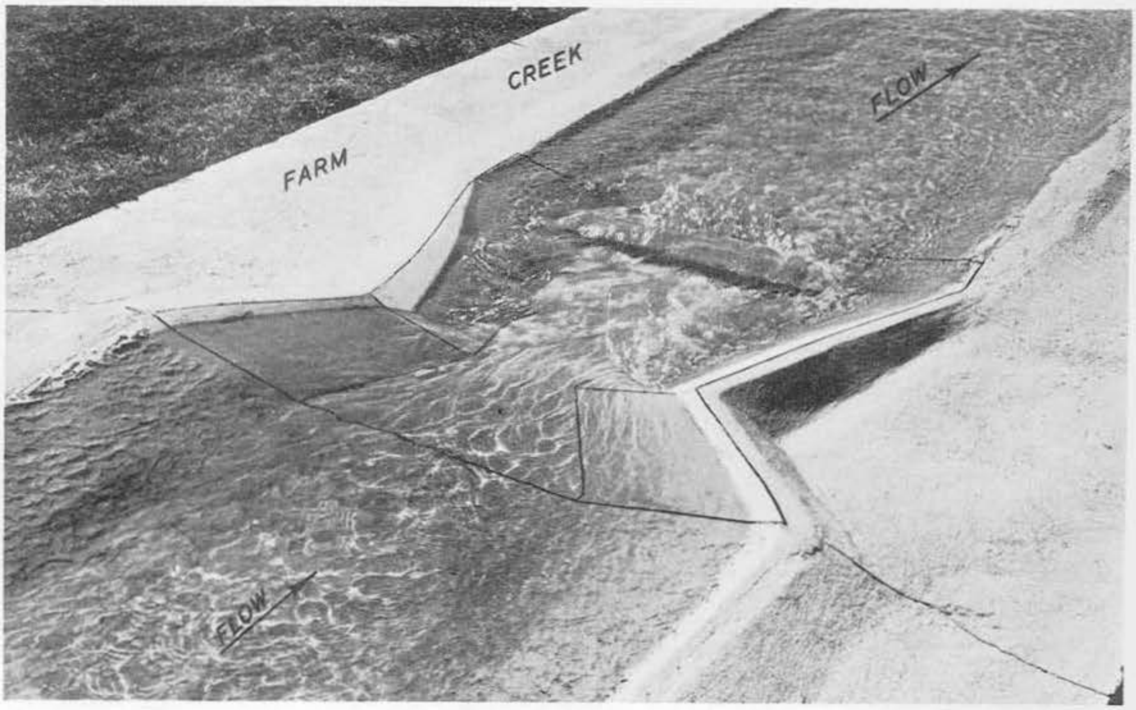


Fig. 11. Flow conditions, final plan for Farm Creek control structure at sta 116+00, discharge 15,500 cfs

Farm Creek Channel Realignment Tests

50. Results of the test of the initial improvement plan showed that the proposed Farm Creek channel alignment in the vicinity of the East Washington Street bridge resulted in undesirable flow conditions (paragraph 25f). Two alternate channel plans (plate 10) were tested to effect improvements.

51. The first alternate, plan 1, involved the use of warped channel slopes extending upstream and downstream from the bridge abutments. The second alternate, plan 2, involved the use of uniformly sloping channel banks throughout the problem area. A flow of 19,400 cfs was used in testing these improvement plans.

52. Test results indicated that both plans were equally effective in eliminating the standing waves between sta 98+00 and 102+50, thereby providing the required clearance under the bridge (plate 10). However, plan 1 was discarded because of expected construction difficulties.

Peoria and Pekin Union Railroad Bridge Tests

53. Tests of the Peoria and Pekin Union Railroad Bridge were concerned with the elimination of the waves (paragraph 25b) created by the bridge abutments and pier. The plan involved an upstream and a downstream extension of the bridge pier. The upstream extension was 67.1 ft long and included a 37.1-ft rounded nose on a 3-on-1 slope; the downstream extension was 55 ft long and included a 30-ft, triangular-shaped nose. A 3.5-ft-high cap was added to the upstream extension

to prevent wave wash. Various changes in alignment of the bridge abutments were made with the pier extensions installed to assist in elimination of the troublesome waves. The final abutment design involved 25-ft and 22.5-ft upstream extensions of the right bank and left bank abutments, respectively (see plate 11 and figure 12). All tests were conducted with a discharge of 22,000 cfs.

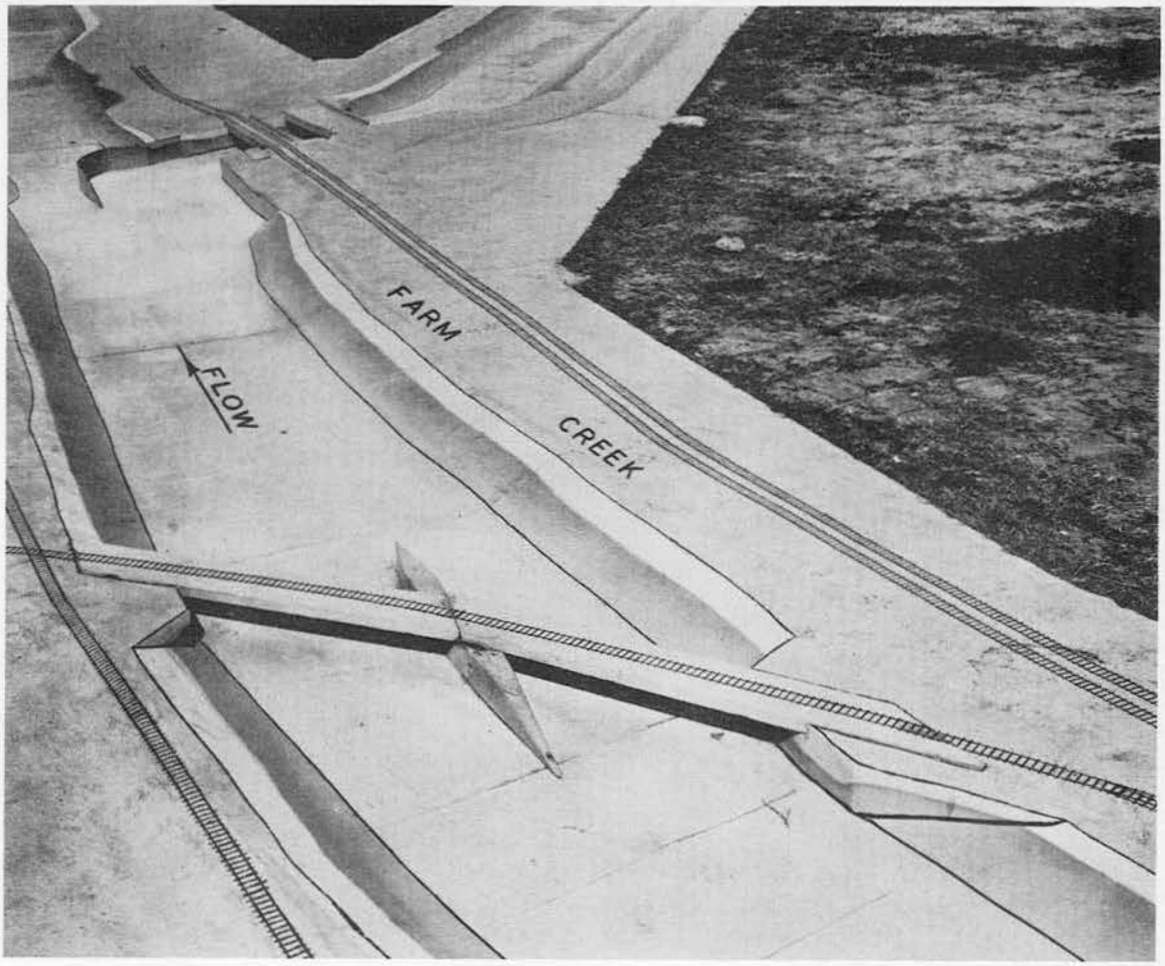


Fig. 12. Final pier and abutment plan for Peoria and Pekin Union Railroad bridge

54. The redesigned bridge abutments and pier eliminated the large waves immediately above and below the bridge as well as the waves under

the bridge which were submerging the sub-structure (figure 13). In

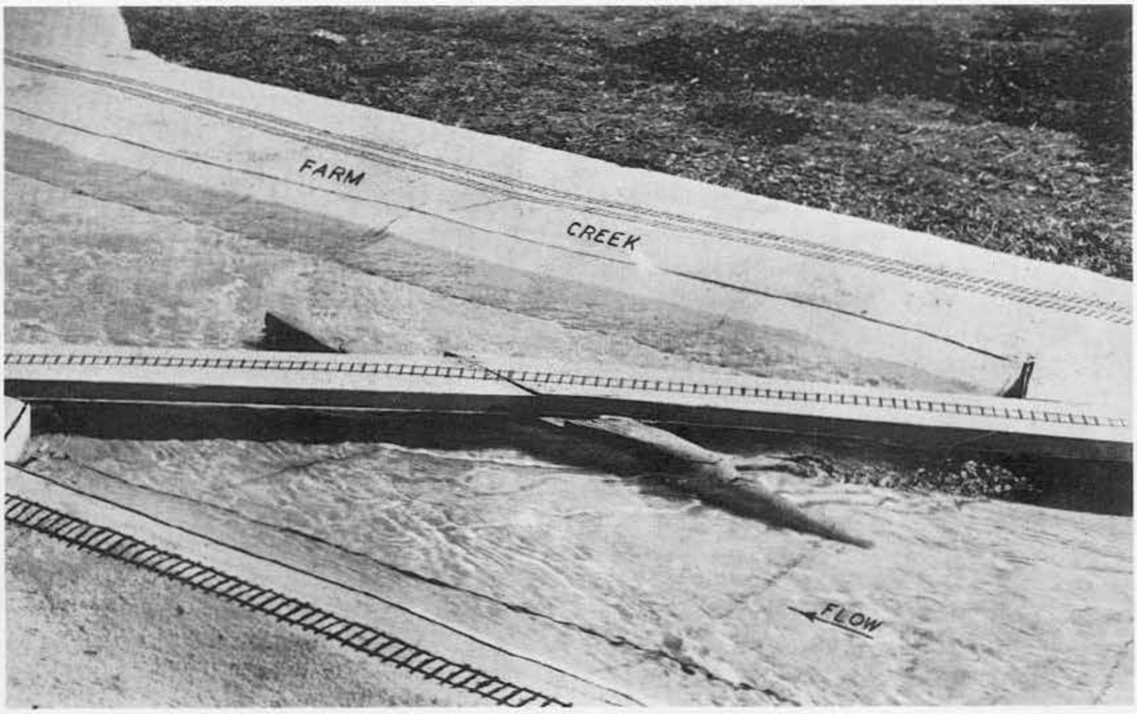


Fig. 13. Flow conditions, final pier and abutment plan for Pekin Union Railroad bridge; discharge 22,000 cfs

addition, a general lowering of water-surface elevations in the problem area was obtained (tables 9 and 10).

PART IV: CONCLUSIONS AND RECOMMENDATIONS

55. Model tests of the Farm Creek improvement plan revealed that while performance of the plan as originally designed was generally satisfactory, certain modifications would further improve the performance and at the same time effect economies in construction costs. These modifications, which are recommended for inclusion in the final design, are summarized below:

a. Redesign of the entrance to the diversion channel (plan 4, paragraphs 35 through 41) to provide for an increase in diversion channel discharges from 8,000 cfs to 12,500 cfs. This alteration, which proved satisfactory in the model tests, would eliminate the necessity for improving the Farm Creek channel below sta 54+00.

b. Redesign of the drop structure in Cole Creek and realignment of the Cole Creek channel at its confluence with Farm Creek (paragraphs 42 to 46) to provide better flow conditions in Cole Creek and to eliminate undesirable waves upstream from the Main Street bridge.

c. Redesign of the Farm Creek control structure at sta 116+00 (plan 4, paragraphs 47 through 49) to provide a 7-ft end sill thereby reducing velocities in the unpaved section downstream.

d. Realignment of the channel in the vicinity of the East Washington Street bridge (plan 2, paragraphs 50 through 52) to eliminate standing waves between sta 98+00 and 102+50, thereby providing the necessary clearance under the bridge.

e. Redesign of the Peoria and Pekin Railroad bridge abutments and piers (paragraphs 53 and 54) to eliminate standing waves and to provide better flow conditions under the bridge.

TABLES

Table 1

PERMANENT GAGE LOCATIONS*

Gage No.	Station No.	Remarks
	Farm Creek	
1	123 + 49.6	Center of channel
2	119 + 60.6	Center of channel
3	116 + 69.6	Center of channel
4	116 + 15.6	Center of channel
5	113 + 90.6	Center of channel
6	110 + 44.2	Center of channel
7	105 + 61.2	Center of channel
8	102 + 72.2	Center of channel
9	102 + 22.2	Center of channel
10	100 + 72.2	Center of channel
11	99 + 00.8	Center of channel
12	92 + 08.8	Left edge of channel
13	92 + 08.8	Right edge of channel
14	84 + 21.2	Left edge of channel
15	84 + 21.2	Right edge of channel
16	76 + 30.0	Left edge of channel
17	76 + 30.0	Right edge of channel
18	71 + 42.7	Center of channel
19	69 + 77.7	Center of channel
20	65 + 72.7	Center of channel
21	64 + 51.7	Left edge of channel
22	64 + 51.7	Right edge of channel
23	61 + 72.7	Center of channel
24	59 + 44.7	Center of channel
25	56 + 54.1	Center of channel
26	53 + 99.1	Center of channel
27	48 + 02.1	Center of channel
28	40 + 49.5	Center of channel
29	34 + 40.5	Center of channel
30	28 + 29.1	Center of channel
31	20 + 49.3	Left edge of channel
32	20 + 49.3	Right edge of channel
33	17 + 63.3	Center of channel
34	16 + 34.3	Center of channel
35	13 + 31.1	Center of channel
36	10 + 37.1	Center of channel
37	5 + 70.0	Center of channel
38	0 - 78.0	Center of channel

(Continued)

* See fig. 3.

Table 1 (Continued)

Gage No.	Station No.	Remarks
	Diversion Channel	
D-1	37 + 00.0	Center of channel
D-2	30 + 75.0	Center of channel
D-3	24 + 96.0	Center of channel
D-4	18 + 72.0	Center of channel
D-5	13 + 02.0	Center of channel
D-6	7 + 02.0	Center of channel
D-7	4 + 14.0	Right edge of channel
D-8	4 + 14.0	Left edge of channel
D-9	1 + 56.0	Right edge of channel
D-10	1 + 56.0	Left edge of channel
D-11	1 + 45.0	Left edge of channel
D-12	0 + 61.0	Center of channel
	Cole Creek	
C-1	22 + 70.0	Center of channel
C-1A	19 + 00.0	Center of channel
C-1B	18 + 50.0	Center of channel
C-2	17 + 00.0	Center of channel
C-3	12 + 00.0	Center of channel
C-4	7 + 20.0	Center of channel
C-5	1 + 50.0	Center of channel
C-6	0 + 40.0	Center of channel
	Kerfoot Creek	
K-1	9 + 17.0	Center of channel
K-2	4 + 82.0	Center of channel
K-3	1 + 10.0	Center of channel

Table 2

WATER-SURFACE ELEVATIONS

Inflow

Farm Creek, 15,500 cfs
Kerfoot Creek, 3,900 cfs
Cole Creek, 2,600 cfs

Outflow

Initial Plan
Farm Creek, 14,000 cfs
Diversion Channel, 8,000 cfs

Final Plan
Farm Creek, 9,500 cfs
Diversion Channel, 12,500 cfs

Gage No.* or Sta	Elevation in Feet msl: Initial Plan Computed**	Elevation in Feet msl: Initial Plan Model	Elevation in Feet msl: Final Plan Model
	Farm Creek		
1	481.5	482.1	482.0
2	481.2	481.1	481.3
3	481.4	481.3	481.5
4	478.4	480.2	480.5
Sta 114 + 83.0	477.4	475.7	
5	477.4	475.3	477.7
Sta 112 + 21.0	477.2	475.5	
6	477.0	475.9	477.7
Sta 108 + 32.0	468.8	476.0	
7	476.4	475.7	477.2
8	474.8	473.8	475.9
9	473.5	473.3	475.2
Sta 101 + 48.0	470.4	472.5	473.3
10	470.2	470.8	470.2
Sta 99 + 35.0	469.7	466.8	
11	469.6	467.8	469.0
Sta 98 + 72.0	469.5	471.8	
Sta 98 + 36.0	469.4	469.7	
12	467.6	466.5	466.8
13	467.6	466.9	467.1
14	465.2	465.5	466.4
15	465.2	465.9	466.4
16	462.9	462.2	461.6
17	462.9	462.2	462.2
Sta 75 + 95	462.8	462.3	461.8

(Continued)

* See table 1 and fig. 3 for gage locations.
** Obtained from profiles supplied by Chicago District.

Table 2 (Continued)

Gage No.* or Sta	Elevation in Feet msl		
	Initial Plan		Final Plan
	Computed**	Model	Model
	Farm Creek (Cont'd)		
Sta 72 + 00	462.3	462.8	463.0
18	462.2	463.0	462.8
Sta 71 + 18	462.0	463.0	464.0
19	460.8	458.7	459.5
Sta 68 + 85	461.0	462.4	460.5(2)
Sta 68 + 25	461.1		460.6(3)
20	461.0	458.8	459.7
21	461.6	461.0(1)	459.7
22	461.6	460.4(1)	459.4
Sta 64 + 75	461.4		461.0(4)
Sta 64 + 65	461.4	464.7	
Sta 64 + 49	461.6		458.9(6)
Sta 64 + 49	461.6		459.9(7)
Sta 64 + 33	461.5	464.7	
Sta 64 + 27	461.4		456.6(8)
Sta 64 + 00	461.0		460.1(9)
Sta 63 + 57	460.6		457.1(10)
Sta 63 + 54	460.5		459.0(11)
Sta 63 + 22	460.4		457.8(12)
23	459.5	459.5	458.9
24	459.0	457.3	458.3
Sta 57 + 20	458.6	458.6	
25	456.6	457.7	459.9
26	458.0	456.8	460.8
Sta 52 + 99	457.9	457.0	
27	457.4	457.3	454.0(5)
28	456.4	456.2	
29	455.7	455.6	
30	455.0	454.8	
31	454.1	453.7	
32	454.1	453.5	
Sta 18 + 12	453.9	453.2	
33	450.9	452.7	
Sta 16 + 92	451.7	450.0	
34	451.7	449.8	
Sta 15 + 75	451.4	452.1	

(Continued)

See notes at end of table for numbers in parentheses.

* See table 1 and fig. 3 for gage locations.

** Obtained from profiles supplied by Chicago District.

Table 2 (Continued)

Gage No.* or Sta	Elevation in Feet msl		
	Initial Plan		Final Plan
	Computed**	Model	Model
	Farm Creek (Cont'd)		
Sta 14 + 20	450.3	453.6	
35	450.0	449.3	
Sta 12 + 64	449.6	449.4	
Sta 11 + 63	450.4	449.9	
Sta 11 + 20	449.7	449.0	
36	449.6	449.3	
37	449.1	449.3	
38	448.0	448.0	
	Diversion Channel		
D-1	450.1	450.6	452.0
D-2	452.1	452.3	452.9
D-3	453.4	453.3	453.5
D-4	454.8	455.0	454.4
D-5	455.7	455.8	455.6
D-6	456.8	456.4	455.9
D-7	457.3	456.4	455.1
D-8	457.3	456.4	455.3
D-9	451.9	455.1	453.5
D-10	451.9	454.7	456.4
D-11	452.2	459.2	460.4
D-12	454.7	455.6	459.7
	Cole Creek		
C-1	477.6(13)	477.4	478.2
C-1-A	476.6	473.7	477.3
C-1-B	474.0	473.0	477.0
C-2	466.2	461.6	461.5
C-3	460.0	463.4	462.2
C-4	461.8	463.4	462.8
C-5	460.3	463.6	463.1
Sta 1 + 05	461.1		
C-6	461.1	464.0	463.4

(Continued)

See notes at end of table for numbers in parentheses.

* See table 1 and fig. 3 for gage locations.

** Obtained from profiles supplied by Chicago District.

Table 2 (Continued)

Gage No.* or Sta	Elevation in Feet msl		
	Initial Plan		Final Plan
	Computed**	Model	Model
	Kerfoot Creek		
K-1	475.3	475.9	477.4
K-2	475.2	475.8	477.2
K-3	475.2	475.6	477.1

(1) Within disturbance caused by bridge pier
(2) Upstream side Main Street bridge
(3) Downstream side Main Street bridge
(4) Upstream center P & PURR bridge
(5) Unimproved channel not installed in model below this gage
(6) Upstream right side of P & PURR bridge pier
(7) Downstream center right span P & PURR bridge
(8) Upstream left side P & PURR bridge pier
(9) Downstream right side P & PURR bridge pier
(10) Downstream center left span P & PURR bridge
(11) Upstream left abutment P & PURR bridge
(12) Downstream left abutment P & PURR bridge
(13) Extrapolated gages C-1 through C-4

* See table 1 and fig. 3 for gage locations.
** Obtained from profiles supplied by Chicago District.

Table 3

VELOCITY OBSERVATIONS

Initial Improvement Plan

Inflows

Farm Creek, 15,500 cfs
Kerfoot Creek, 3,900 cfs
Cole Creek, 2,600 cfs

Outflows

Farm Creek, 14,000 cfs
Diversion Channel, 8,000 cfs

Station	Maximum Velocities*	Remarks
	Farm Creek	
2 + 46	7.8	Unpaved
9 + 00	11.0	Unpaved
21 + 65	9.4	Unpaved
34 + 00	8.2	Unpaved
43 + 60	8.8	Unpaved
50 + 80	12.2	Unpaved
54 + 00	14.6	Lower end of paving
90 + 06	15.0	Paved
107 + 00	12.6	Unpaved
112 + 00	14.0	Unpaved
115 + 00	16.3	Lower end of paving
118 + 25	7.4	Unpaved
121 + 25	10.2	Unpaved
	Diversion Channel	
3 + 37	10.8	Paved
6 + 15	6.8	Unpaved
12 + 15	6.4	Unpaved
19 + 65	7.4	Unpaved
27 + 15	9.4	Unpaved
36 + 15	9.5	Unpaved
	Cole Creek	
0 + 90	5.3	Paved
20 + 27	11.4	Unpaved
	Kerfoot Creek	
4 + 00	4.3	Unpaved
8 + 02	6.7	Unpaved

*Velocities are shown in ft per sec (prototype) and were taken at middepths.

Table 4

WATER-SURFACE ELEVATIONS

Diversion Channel Improvement Plans

Inflow	Outflow
Farm Creek, 15,500 cfs Kerfoot Creek, 3,900 cfs Cole Creek, 2,600 cfs	Farm Creek, variable Diversion Channel, variable

Diversion Channel	8,000 cfs	8,100 cfs	9,200 cfs	12,200 cfs	12,500 cfs
	Elevation in Feet msl				
Gage No.* or Sta	Initial Plan	Plan 1	Plan 2	Plan 3	Final Plan
			Farm Creek		
Gage 23	459.5	459.8	459.5	459.8	458.9
Gage 24	457.3	457.4	457.0	456.8	458.3
Sta 57 + 20	458.6		455.1		
Gage 25	457.7	457.9	457.6	458.8	459.9
Sta 55 + 52			454.2		
Sta 55 + 28			457.5		
Sta 54 + 80			456.8		
Gage 26	456.8	456.4	456.1	454.0	460.8
Gage 27	457.3	457.4	457.0	455.2	454.0
			Diversion Channel		
D-1	450.6	450.8	451.3	452.0	452.0
D-2	452.3	452.6	452.9	452.3	452.9
D-3	453.3	453.5	454.2	453.5	453.5
D-4	455.0	455.2	455.6	454.4	454.4
D-5	455.8	456.1	456.8	455.5	455.6
D-6	456.4	456.7	457.3	456.0	455.9
D-7	456.4	457.1	457.3	455.6	455.1
D-8	456.5	456.9	457.2	454.4	455.3
Sta 3 + 50		458.1	458.0		450.2
D-9	455.1	456.1	456.8	454.4	453.5
D-10	454.7	456.1	457.1	454.3	456.4
D-11	459.2	459.0	459.8	460.1	460.4
D-12	455.6	453.6	457.6	458.2	459.7

* See table 1 and fig. 3 for gage locations.

Table 5

VELOCITY OBSERVATIONS

Diversion Channel Improvement Plans

Inflow	Outflow
Farm Creek, 15,500 cfs Kerfoot Creek, 3,900 cfs Cole Creek, 2,600 cfs	Farm Creek, variable Diversion Channel, variable

Diversion Channel	8,000 cfs	9,200 cfs	12,200 cfs	12,500 cfs
	Maximum Velocities*			
Station	Initial Plan	Plan 2	Plan 3	Final Plan
	Diversion Channel			
3 + 37	10.8	12.9	13.9	13.9
6 + 15	9.7	9.8	11.4	10.1
12 + 15	6.4	7.1	8.3	8.8
19 + 65	7.4	8.1	8.3	8.5
27 + 15	9.4	9.5	7.5	7.0
36 + 15	9.5	10.2	7.0	7.0

* Velocities are shown in ft per sec (prototype) and were taken at mid-depths.

Table 6

WATER-SURFACE ELEVATIONS

Cole Creek Final Improvement Plan

Farm Creek, 9,800 cfs
Kerfoot Creek, 5,300 cfs
Cole Creek, 3,600 cfs

Farm Creek, 7,700 cfs
Diversion Channel, 11,000 cfs

Gage No.	Elev in Ft, msl	Proposed Top of Wall in Ft, msl	Freeboard in Ft
C-1	480.3	483.8	3.5
C-1A	479.9	483.5	3.6
C-1B	479.3	483.1	3.8
C-2	462.5	469.6	7.1
C-3	463.0	467.7	4.7
C-4	460.1	466.0	5.9
C-5	462.5	463.8	1.3
C-6	463.3	463.4	0.1

Note: Center-line station numbers of gages are shown in table 1.

Table 7

WATER-SURFACE ELEVATIONS

Farm Creek Control Structure Sta 116+00

Inflow	Outflow
Farm Creek, 15,500 cfs	Farm Creek, variable
Kerfoot Creek, 3,900 cfs	Diversion Channel, variable
Cole Creek, 2,600 cfs	

Gage No.* or Sta	Initial Plan	Plan 1	Plan 2	Plan 3	Final Plan Plan 4
Gage 3	481.3	481.4	481.0	481.4	481.6
Gage 4	480.2	480.5	480.1	480.4	480.7
Sta 114 + 83.0	475.7	478.4	479.5	472.7	473.1
Gage 5	475.3	476.2	476.6	477.4	478.1
Sta 112 + 21.0	475.5	476.6	477.3	477.4	478.1
Gage 6	475.9	476.4	476.6	477.1	477.9
Sta 108 + 32.0	476.0				
Gage 7	475.7	475.8	475.8	476.2	477.9
Gage 8	473.8	473.8	473.9	474.3	477.2

* See table 1 and fig. 3 for gage locations.

Table 8

VELOCITY OBSERVATIONS

Farm Creek Control Structure Sta 116+00

Inflow

Farm Creek, 15,500 cfs
Kerfoot Creek, 3,900 cfs
Cole Creek, 2,600 cfs

Outflow

Farm Creek, variable.
Diversion Channel, variable.

	Maximum Velocities*				
Station	Initial Plan	Plan 1	Plan 2	Plan 3	Final Plan Plan 4
			Farm Creek		
90 + 10	15.0	15.3			
99 + 35					14.9
107 + 50	12.6	10.2	10.2	10.2	7.0
112 + 00	14.0	12.9	8.5	8.3	8.3
115 + 00	16.3	16.9	15.5	13.9	15.5
118 + 25	7.4	7.8	8.3	8.3	6.5
121 + 25	10.2	10.5			

* Velocities are shown in ft per sec (prototype) and were taken at mid-depths.

Table 9

WATER-SURFACE ELEVATIONS

Tests of Extensions to P. & P.U.R.R. Bridge Pier, Farm Creek

Inflow

Farm Creek, 15,500 cfs
Kerfoot Creek, 3,900 cfs
Cole Creek, 2,600 cfs

Outflow

Farm Creek, 9,500 cfs
Diversion Channel, 12,500 cfs

Gage No.* or Sta	Elev in Ft, msl Initial Plan	Final Plan	Remarks
Gage 19	459.7	459.5	
Gage 20	459.3	459.7	
Sta 64 + 75	460.2	461.0	Upstream edge of bridge center of right span
Gage 21	461.0	459.7	
Gage 22	460.9	459.4	
Sta 64 + 49	463.1	458.9	Upstream edge of bridge at right side of pier
Sta 64 + 49	460.9	459.9	Downstream edge of bridge center of right span
Sta 64 + 27	458.7	456.6	Upstream edge of bridge near left side of pier
Sta 64 + 00	460.8	460.1	Downstream edge of bridge near right side of pier
Sta 63 + 57	459.2	457.1	Downstream edge of bridge center of left span
Sta 63 + 54	460.2	459.0	Upstream edge of bridge near left abutment
Sta 63 + 22	460.4	457.8	Downstream edge of bridge near left abutment
Gage 23	459.5	458.9	
Gage 24	457.3	458.3	

* See table 1 and fig. 3 for gage locations.

Table 10

WATER-SURFACE ELEVATIONS

Tests of Revisions to Abutments of P. & P.U.R.R. Bridge, Farm Creek

Inflow

Farm Creek, 15,500 cfs
Kerfoot Creek, 3,900 cfs
Cole Creek, 2,600 cfs

Outflow

Farm Creek, 9,500 cfs
Diversion Channel, 12,500 cfs

Gage No.* or Sta	Elevation in Ft, msl					Remarks
	Plan 1**	Plan 2	Plan 3	Plan 4	Final Plan	
Gage 19	459.5	460.7	459.7	459.9	459.6	
Gage 20	458.8	461.6	458.6	461.7	460.0	
Sta 64+75	461.6	457.6	460.7	457.4	460.3	Upstream edge of bridge center of right span
Gage 21	459.0	459.5	459.2	459.5	459.8	
Gage 22	459.5	457.4	459.8	457.9	459.4	
Sta 64+49	461.0	458.6	459.9	458.9	459.9	Upstream edge of bridge near right side of pier
Sta 64+49		457.7	459.4	457.8	459.1	Downstream edge of bridge center of right span
Sta 64+27	457.6	458.4	457.3	457.9	458.1	Upstream edge of bridge near left side of pier
Sta 64+00	460.5	457.6	459.5	456.0	459.6	Downstream edge of bridge near right side of pier

(Continued)

* See table 1 and fig. 3 for gage location.
** Plan 1 is initial plan with extensions on P. & P.U.R.R. bridge pier installed.

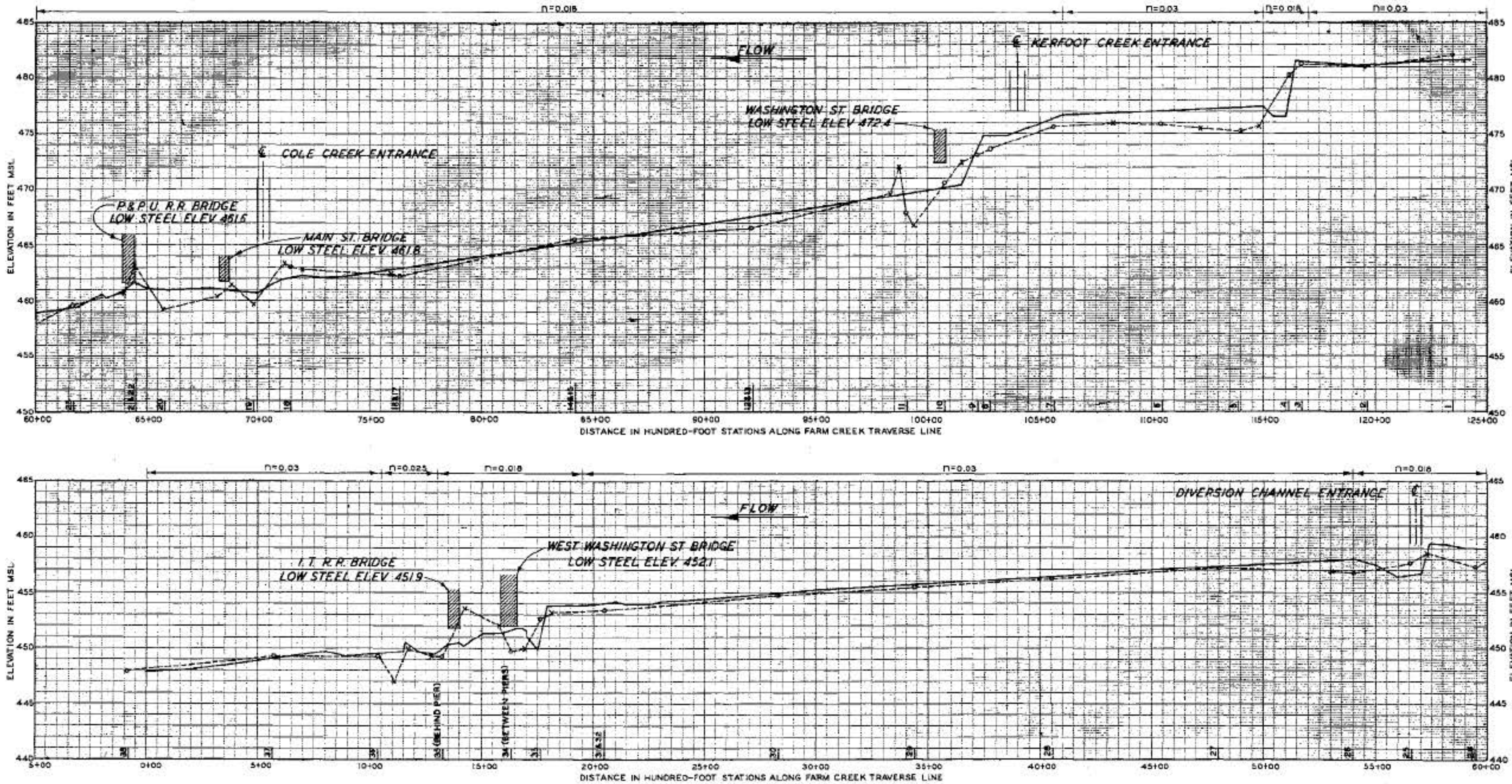
Table 10 (Continued)

Inflow	Outflow
Farm Creek, 15,500 cfs Kerfoot Creek, 3,900 cfs Cole Creek, 2,600 cfs	Farm Creek, 9,500 cfs Diversion Channel, 12,500 cfs

Gage No.* or Sta	Elevation in Ft, msl					Remarks
	Plan 1**	Plan 2	Plan 3	Plan 4	Final Plan	
Sta 63+57	460.5	458.2	457.5	457.4	457.4	Downstream edge of bridge center of left span
Sta 63+54		459.5	458.6	458.8	458.8	Upstream edge of bridge near left abutment
Sta 63+22		457.6	458.3	457.1	458.2	Downstream edge of bridge near left abutment
Gage 23	459.3	459.7	459.7	459.7	459.1	
Gage 24	459.2	458.9	459.5	459.4	459.1	

* See table 1 and fig. 3 for gage location.
** Plan 1 is initial plan with extensions on P & P U R R bridge pier installed.

PLATES



LEGEND

————	COMPUTED WATER SURFACE PROFILE
- - - - -	WATER SURFACE INITIAL PLAN
o	WATER SURFACE ELEVATIONS AT PERMANENT GAGES
x	WATER SURFACE ELEVATIONS AT TEMPORARY GAGES
17	PERMANENT MODEL GAGES CENTER OF CHANNEL
2&3	PERMANENT MODEL GAGES LEFT AND RIGHT EDGES OF CHANNEL RESPECTIVELY

TEST CONDITIONS

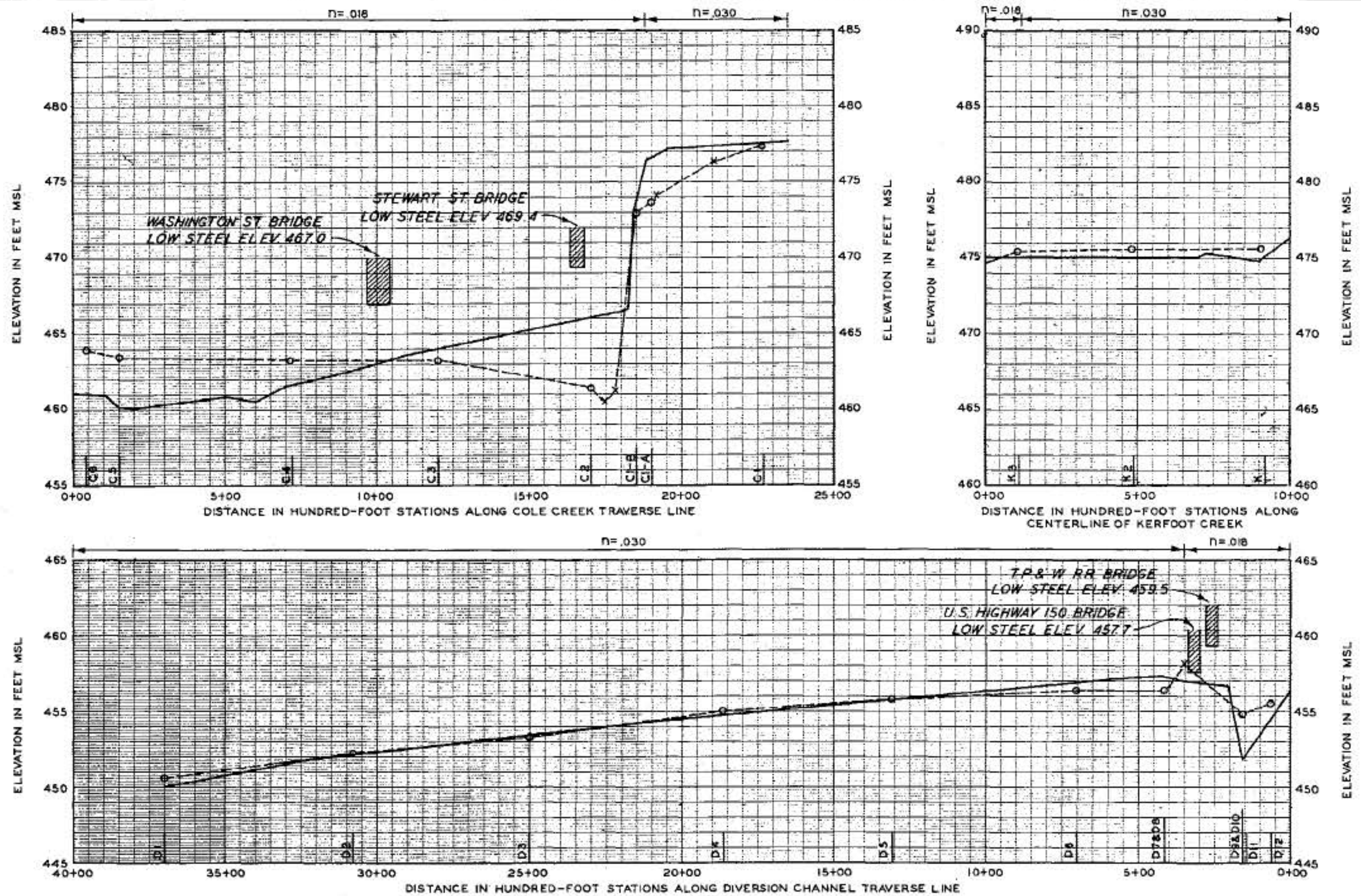
INFLOW		OUTFLOW	
FARM CREEK=	15,500 CFS	FARM CREEK=	14,000 CFS
KERFOOT CREEK=	3,900 CFS	DIVERSION CHANNEL=	8,000 CFS
COLE CREEK=	2,600 CFS		

PROFILES ALONG CENTER LINE OF CHANNEL

INITIAL PLAN

FARM CREEK

PLATE 2



- - - - - - WATER-SURFACE PROFILE INITIAL PLAN
——— COMPUTED WATER-SURFACE PROFILE
o WATER-SURFACE ELEVATION AT PERMANENT GAGES
x WATER-SURFACE ELEVATION AT TEMPORARY GAGES
D4 PERMANENT MODEL GAGES CENTER OF CHANNEL
D7&D8 PERMANENT MODEL GAGES RIGHT AND LEFT EDGES OF CHANNEL RESPECTIVELY

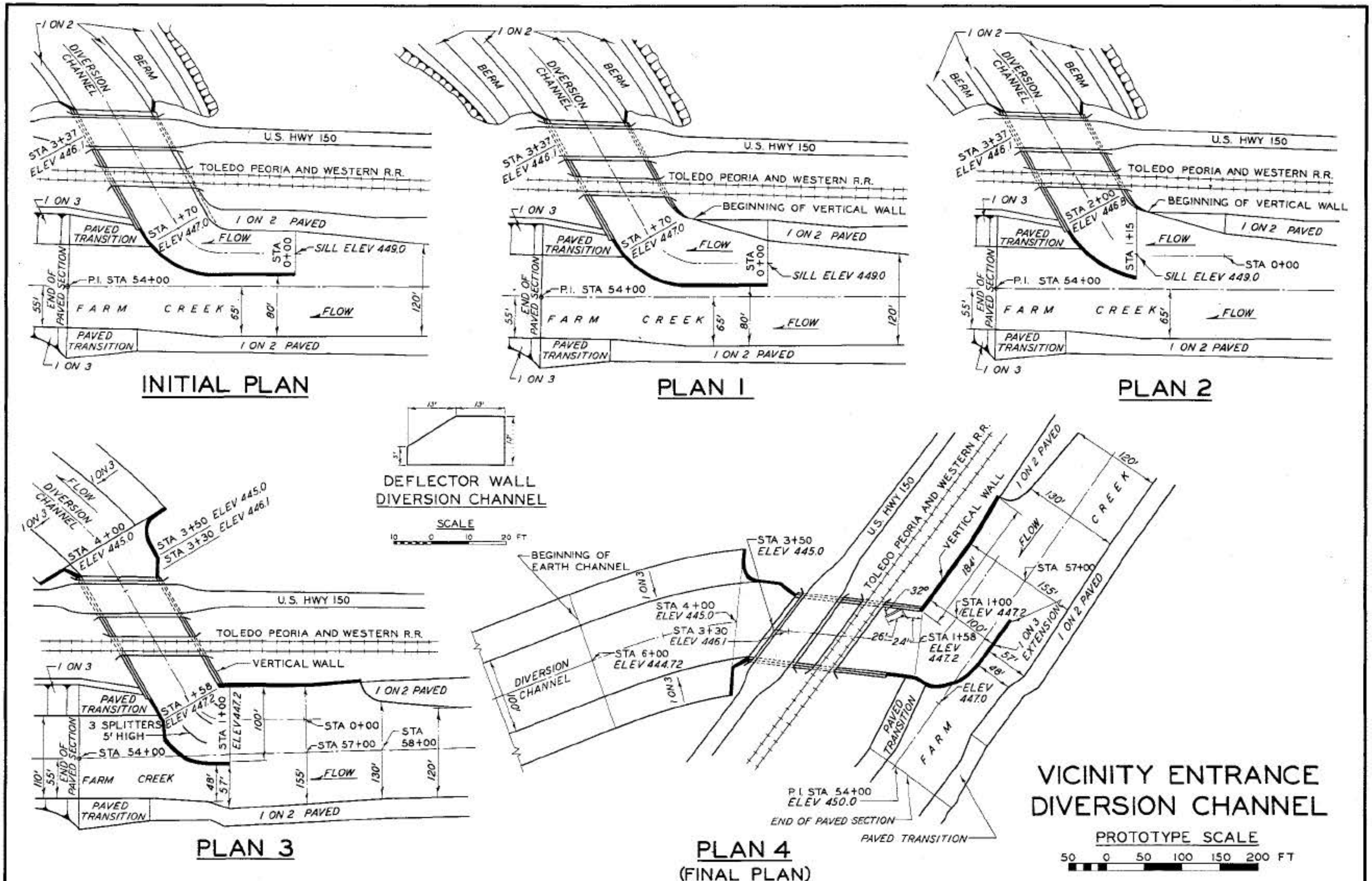
FLOW CONDITIONS

INFLOW		OUTFLOW	
FARM CREEK=	15,500 CFS	FARM CREEK=	14,000 CFS
KERFOOT CREEK	3,900 CFS	DIVERSION CHANNEL	8,000 CFS
COLE CREEK	2,600 CFS		

PROFILES ALONG CENTER LINE OF CHANNEL

INITIAL PLAN

COLE AND KERFOOT CREEKS AND DIVERSION CHANNEL

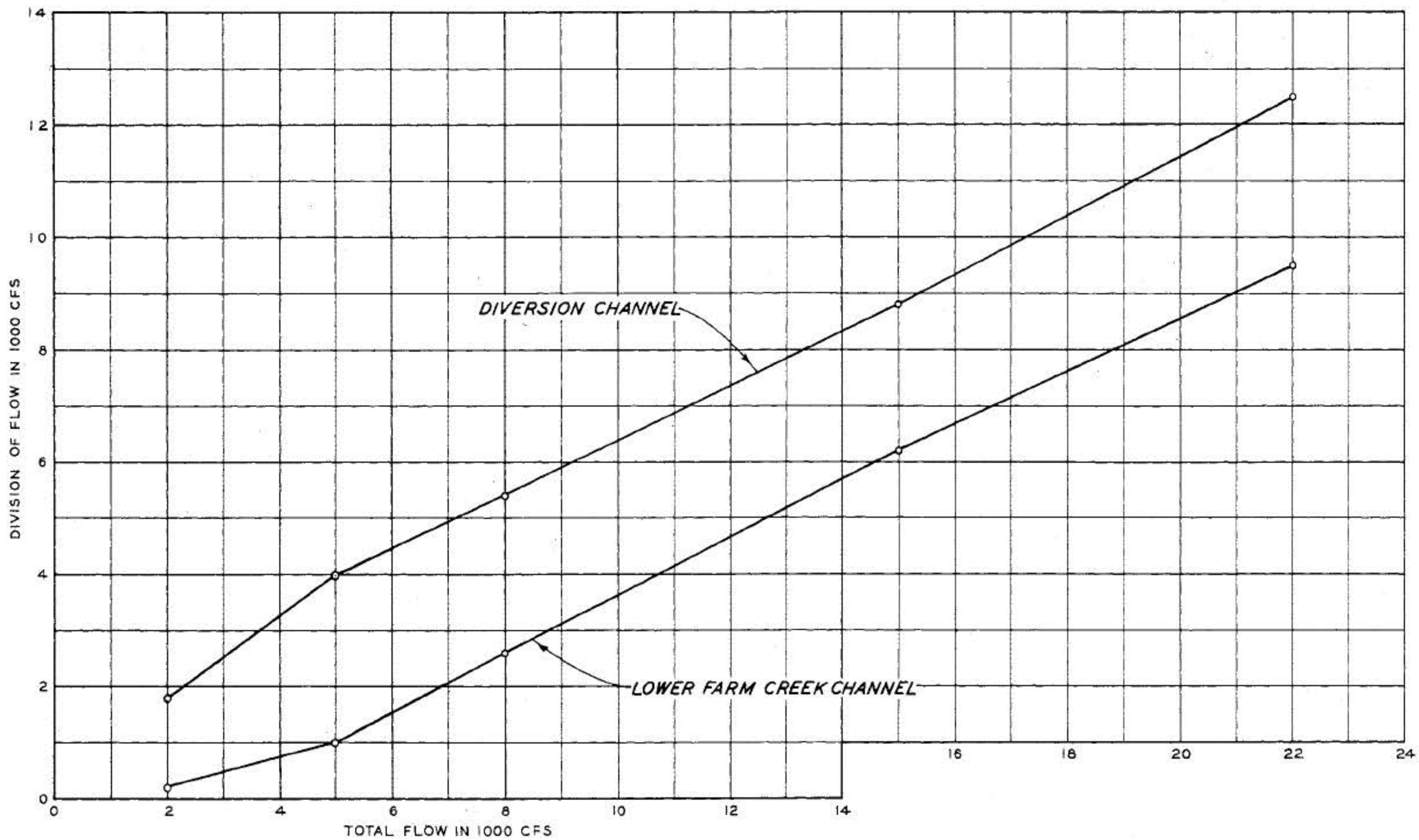


VICINITY ENTRANCE
DIVERSION CHANNEL

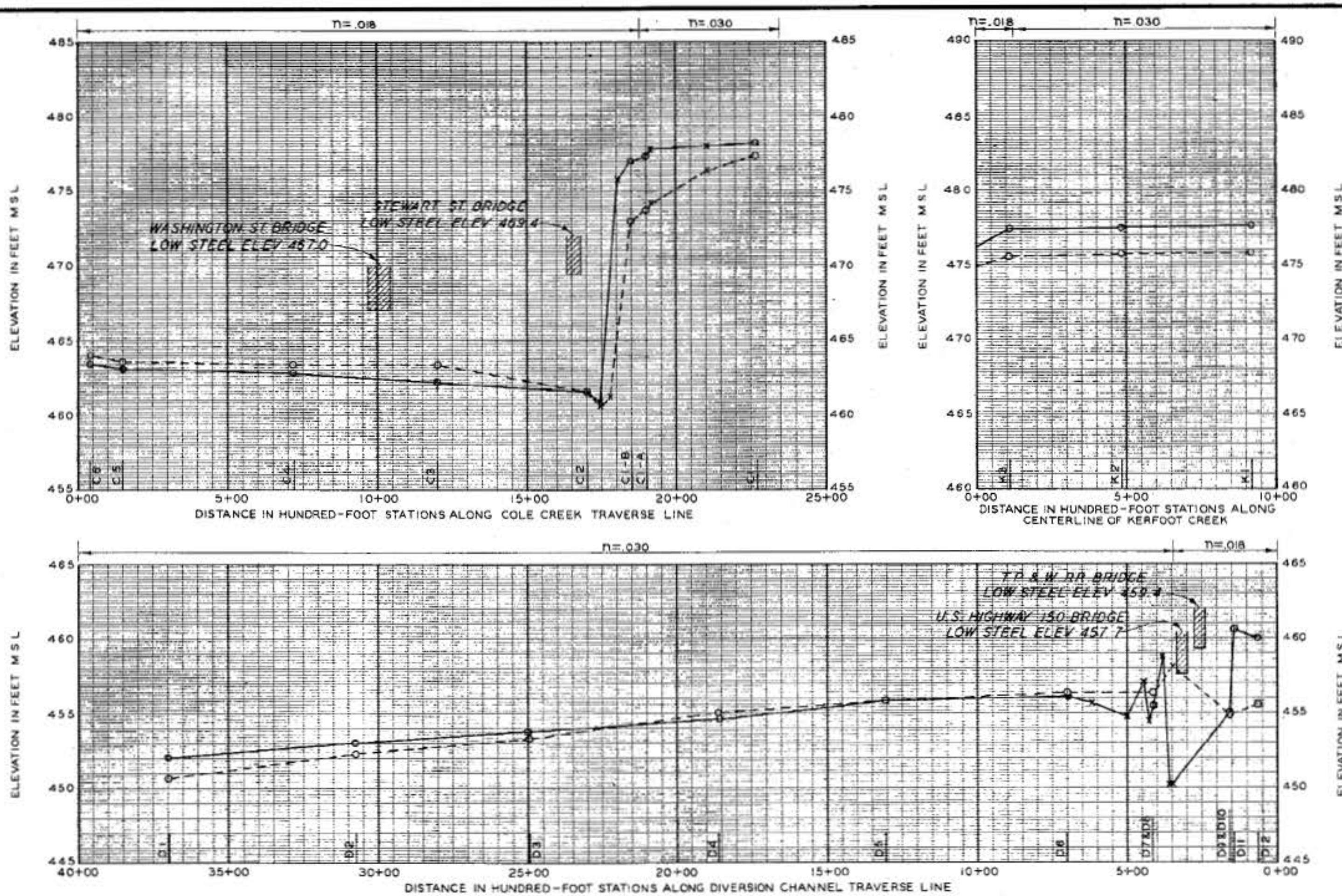
PROTOTYPE SCALE
50 0 50 100 150 200 FT

PLATE 3

PLATE 4



FARM CREEK-DIVERSION CHANNEL
DISCHARGE



LEGEND

- - - - - WATER-SURFACE PROFILE INITIAL PLAN
——— WATER-SURFACE PROFILE FINAL PLAN
o WATER-SURFACE ELEVATION AT PERMANENT GAGES
x WATER-SURFACE ELEVATION AT TEMPORARY GAGES
D4 PERMANENT MODEL GAGES CENTER OF CHANNEL
D7 & D8 PERMANENT MODEL GAGES RIGHT AND LEFT EDGES OF CHANNEL RESPECTIVELY

FLOW CONDITIONS

INFLOW		OUTFLOW ORIGINAL DESIGN		FINAL DESIGN
FARM CREEK =	15,500 CFS	FARM CREEK =	14,000 CFS	9,500 CFS
KERFOOT CREEK =	3,900 CFS	DIVERSION CHANNEL =	8,000 CFS	12,500 CFS
COLE CREEK =	2,600 CFS			

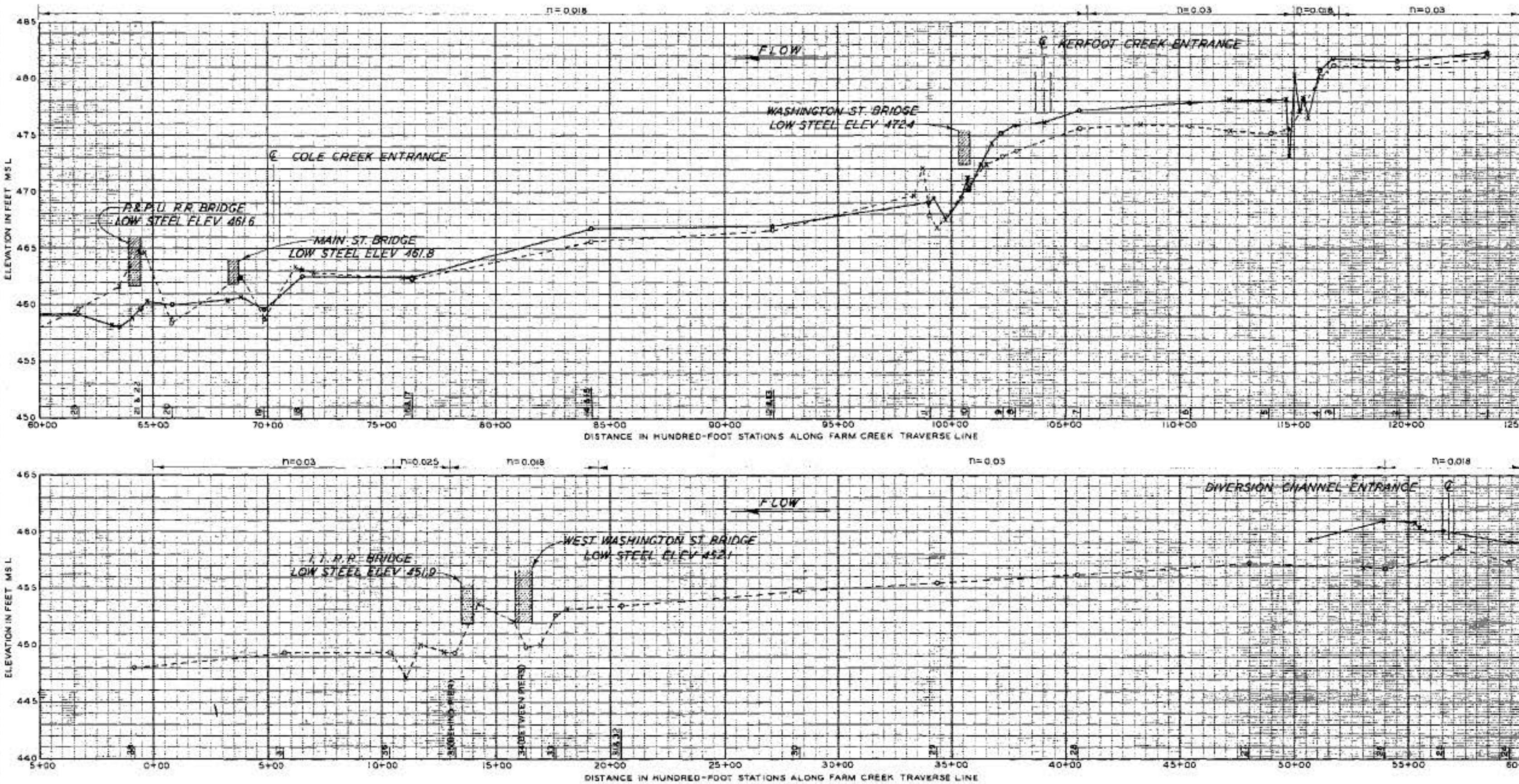
PROFILES ALONG CENTER LINE OF CHANNEL

FINAL PLAN

COLE AND KERFOOT CREEKS AND DIVERSION CHANNEL

PLATE 5

PLATE 6



LEGEND

- ------ WATER SURFACE PROFILE INITIAL PLAN
- —— WATER SURFACE PROFILE FINAL PLAN
- o WATER SURFACE ELEVATIONS AT PERMANENT GAGES
- x WATER SURFACE ELEVATIONS AT TEMPORARY GAGES
- 7 PERMANENT MODEL GAGES CENTER OF CHANNEL
- 12&13 PERMANENT MODEL GAGES LEFT AND RIGHT EDGES OF CHANNEL RESPECTIVELY

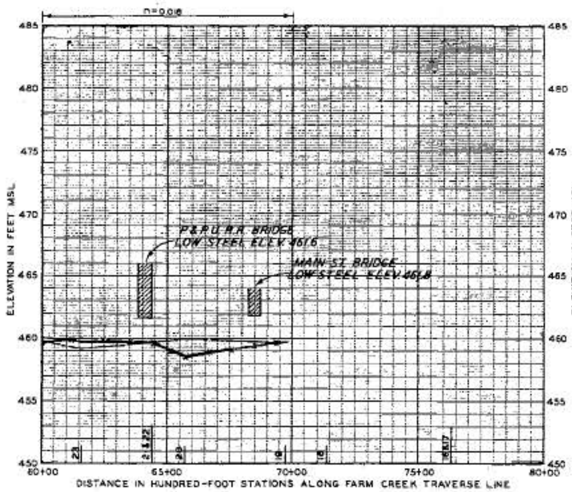
TEST CONDITIONS

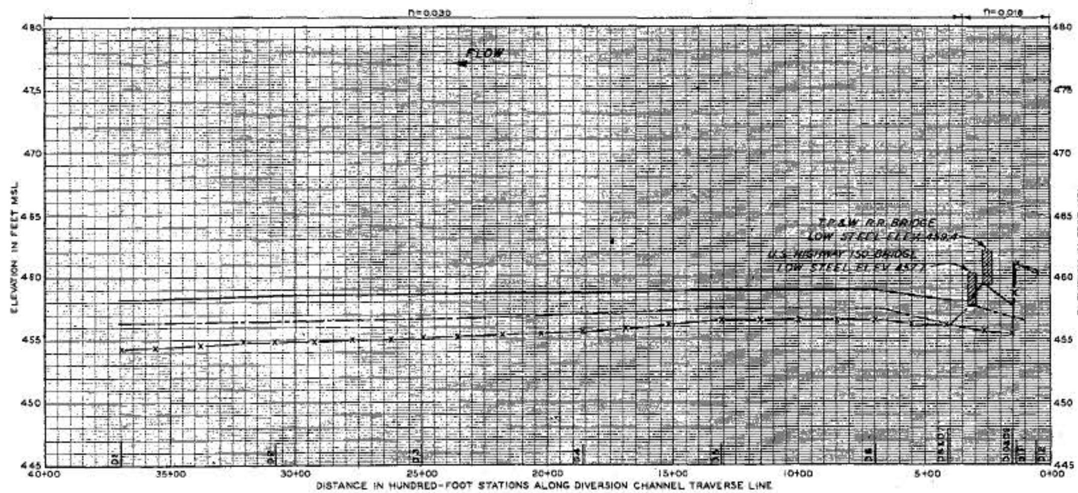
INFLOW		OUTFLOW ORIGINAL DESIGN		FINAL
FARM CREEK =	15,500 CFS	FARM CREEK =	14,000 CFS	9,500 CFS
KERFOOT CREEK =	3,900 CFS	DIVERSION CHANNEL =	8,000 CFS	12,500 CFS
COLE CREEK =	2,600 CFS			

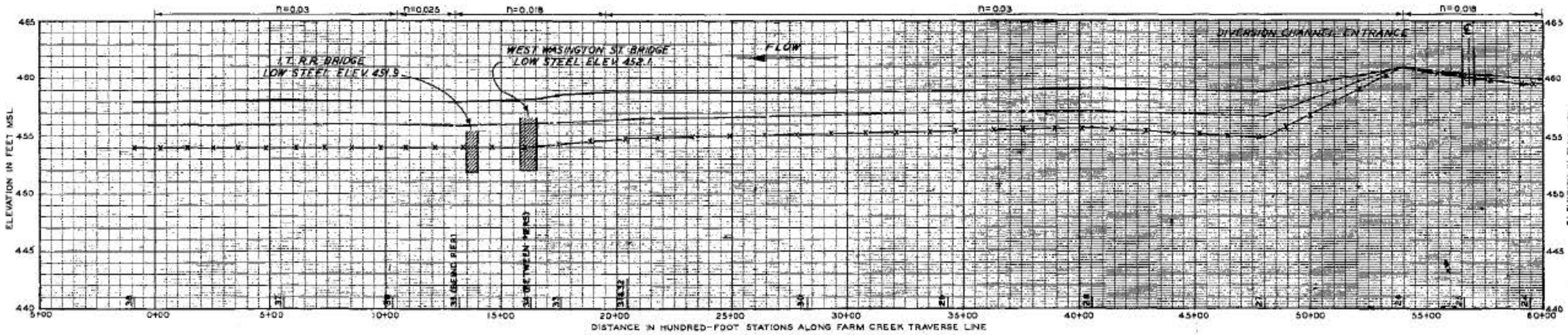
PROFILES ALONG CENTER LINE OF CHANNEL

FINAL PLAN

FARM CREEK







LEGEND

- WATER-SURFACE PROFILE 458 STAGE
- WATER-SURFACE PROFILE 456 STAGE
- WATER-SURFACE PROFILE 454 STAGE
- 37 PERMANENT MODEL GAGES CENTER OF CHANNEL
- 31&32 PERMANENT MODEL GAGES LEFT AND RIGHT EDGES OF CHANNEL RESPECTIVELY.

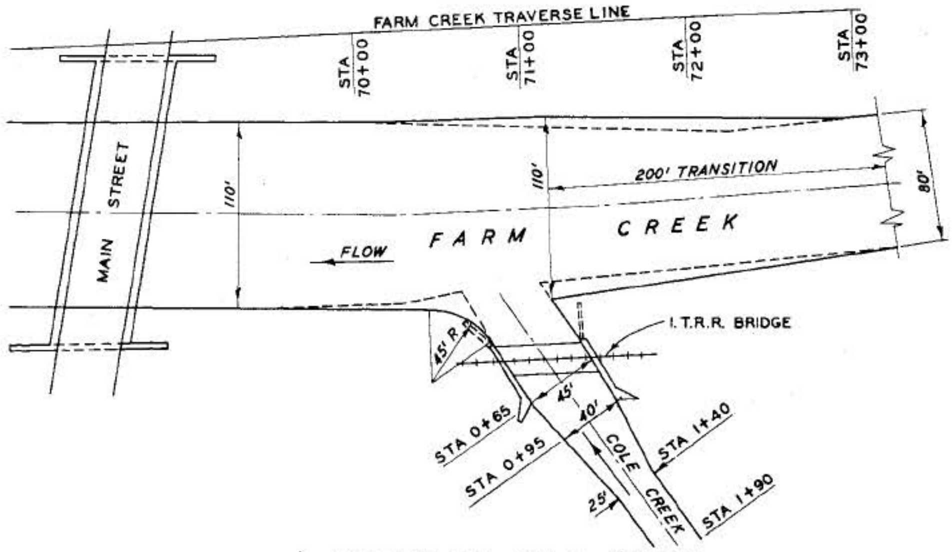
22,000 CFS FLOW CONDITIONS

458 STAGE - FARM CREEK 9,900 CFS - DIVERSION CHANNEL 12,100 CFS
456 STAGE - FARM CREEK 9,900 CFS - DIVERSION CHANNEL 12,100 CFS
454 STAGE - FARM CREEK 9,500 CFS - DIVERSION CHANNEL 12,500 CFS

PROFILES ALONG CENTER LINE OF CHANNEL

VARIOUS ILLINOIS RIVER STAGES

PLATE 7



MOUTH OF COLE CREEK

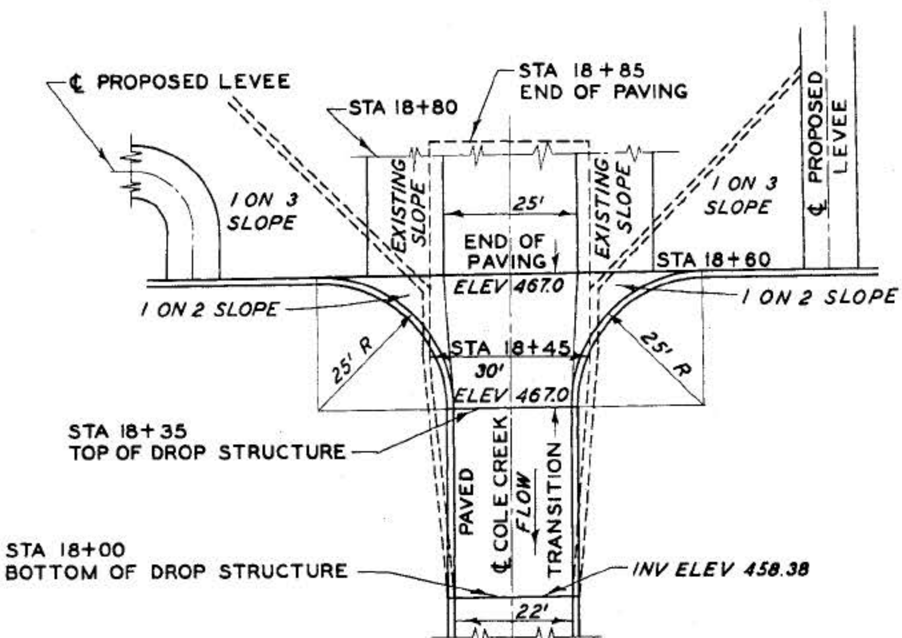
SCALE

50 0 50 100 FT

LEGEND

------ ORIGINAL DESIGN (BASE TEST)

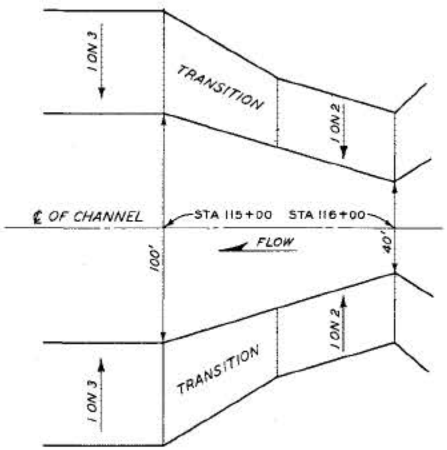
——— FINAL DESIGN



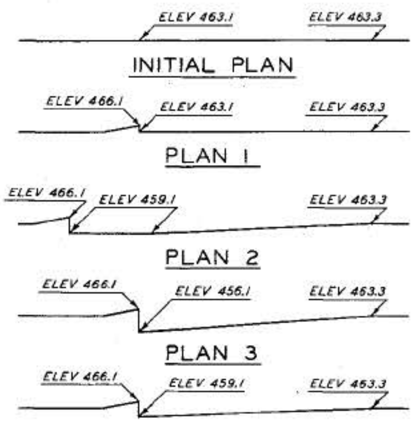
DROP STRUCTURE–COLE CREEK

SCALE

20 0 20 40 FT

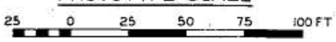


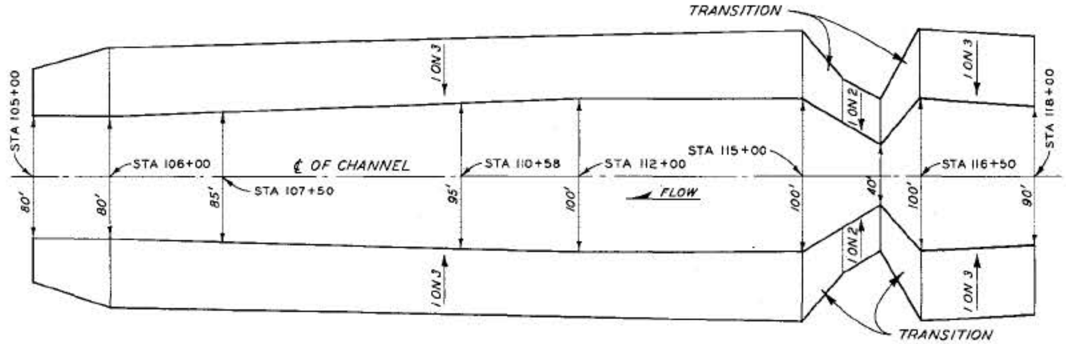
PLAN VIEW



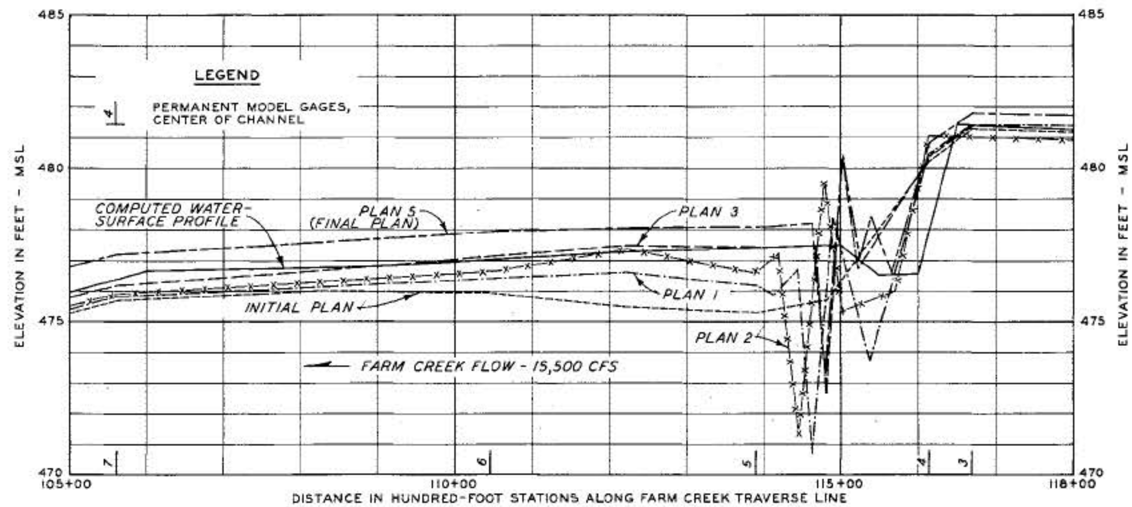
BOTTOM PROFILES

PROTOTYPE SCALE





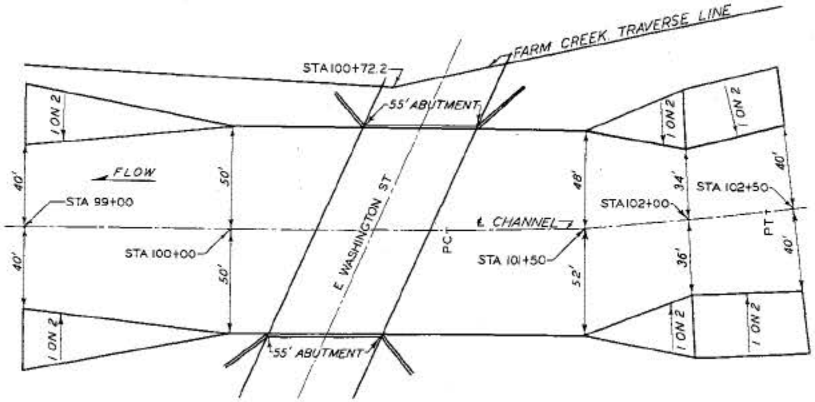
PLAN OF CHANNEL



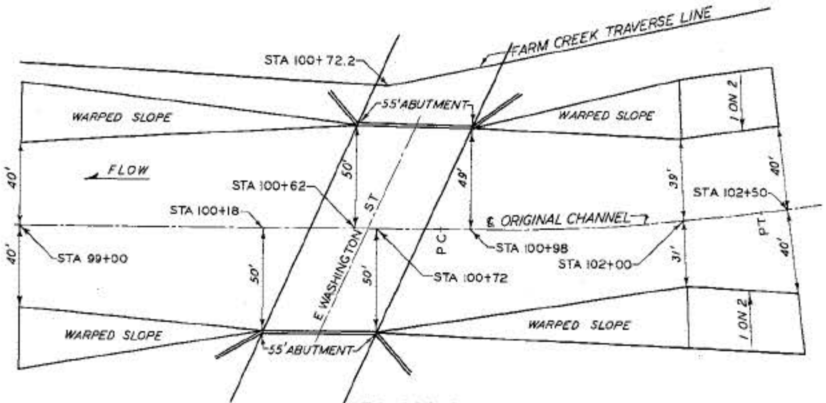
WATER-SURFACE PROFILES - FARM CREEK

CONTROL SECTION - STATION 116+00

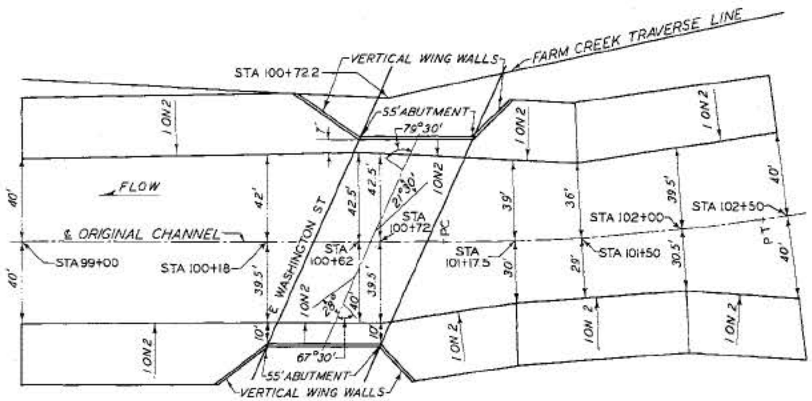
PLATE 9



INITIAL PLAN

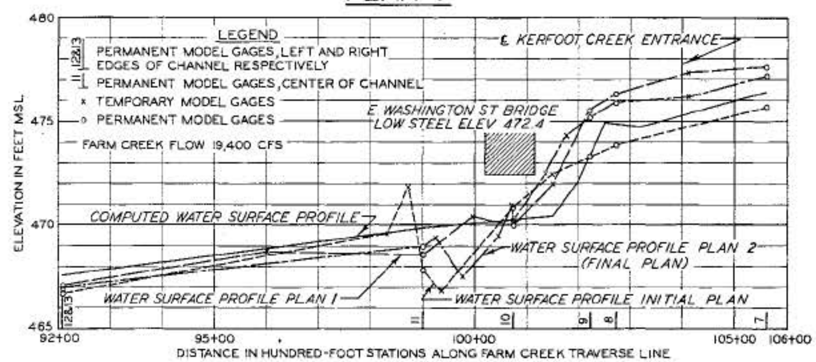


PLAN 1



PLAN 2

(FINAL PLAN)

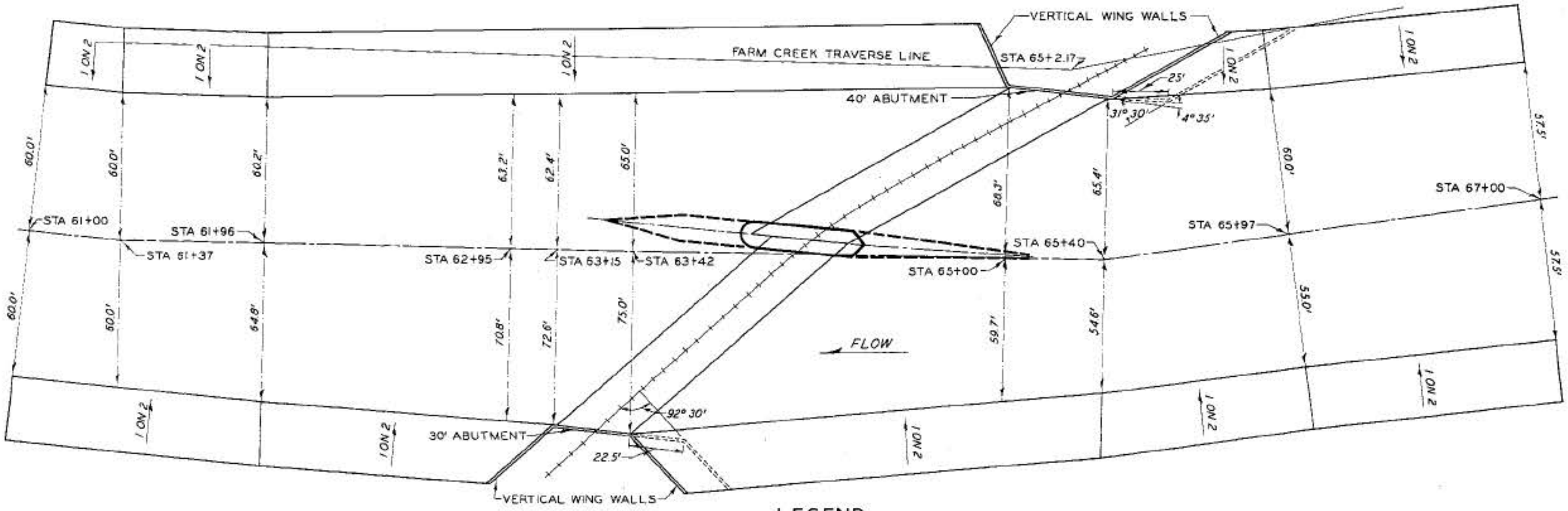


WATER SURFACE PROFILES
VICINITY E WASHINGTON ST BRIDGE

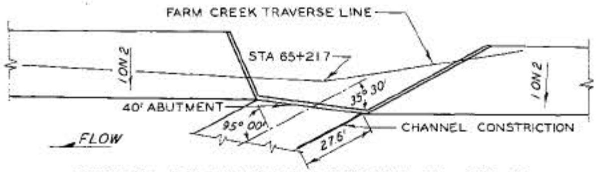
VICINITY EAST WASHINGTON STREET BRIDGE

PROTOTYPE SCALE

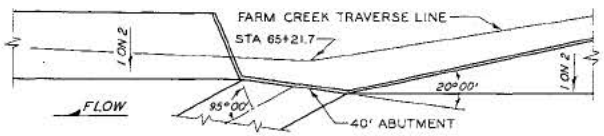
25 0 25 50 75 100 FT



LEGEND
——— INITIAL PLAN
- - - - FINAL PLAN

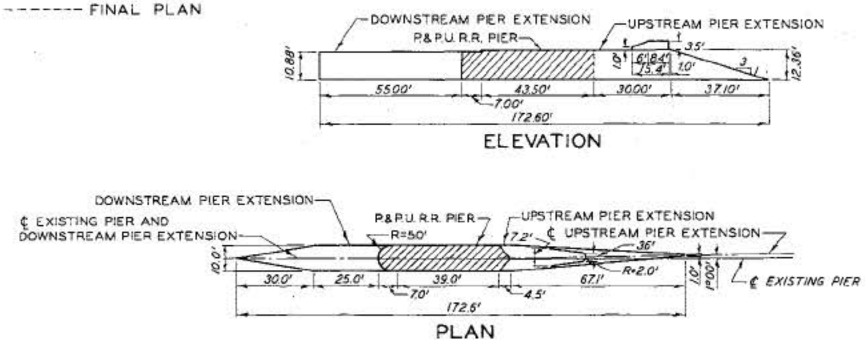


RIGHT BANK ABUTMENT PLAN 2



RIGHT BANK ABUTMENT PLAN 3

RIGHT BANK ABUTMENT PLAN 4



P. & P.U. R.R. BRIDGE PIER & EXTENSIONS

VICINITY PEORIA AND PEKIN UNION RAILROAD BRIDGE

PROTOTYPE SCALE

20 0 20 40 60 80 FT